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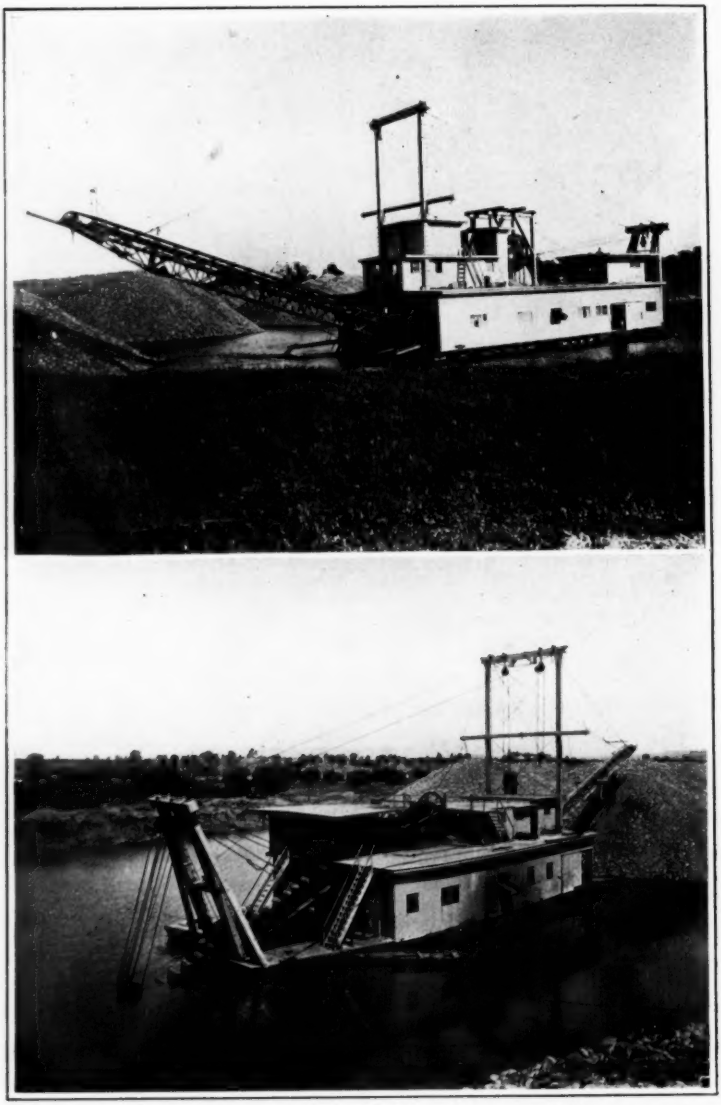
THE GOLD SHIPS AND THEIR CARGOES.

By Alex. Del Mar, M. E.

Mr. Del Mar's ranking position as an authority upon the production and the use of the precious metals as money, will lend added impressiveness to his estimate of the certain effect of the gold dredge in multiplying the world's output of gold. His paper will shortly be followed by the announcement of two most important contributions upon closely related topics, to appear immediately in THE ENGINEERING MAGAZINE. Both will be by the very highest authorities in the field. Together they will serve to forecast and interpret accurately the total output of gold in the near future, and its effect upon the expansion of industry and commerce.—THE EDITORS.

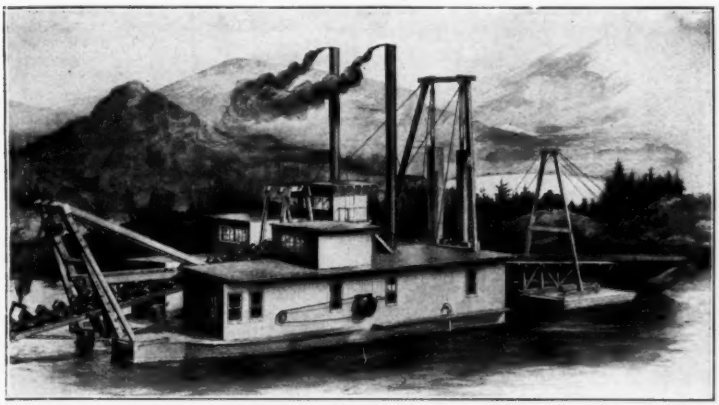
THERE is a strange machine, a sort of phantom ship, which at this moment is beginning to move over the abandoned placers of California to gather up their neglected treasures, and which in a few years will move over the placers of Siberia, Brazil, and Peru, to gather up their wealth, until even the present unprecedented and phenomenal product of gold will be doubled. Ten years ago, the world's annual yield of the yellow metal was half a million dollars per diem; today it is a million; within the next ten years it will be two millions. The social and economical consequences of this tremendous development of gold mining are almost beyond calculation. Without discussing the consequences, let us examine the fact.

The increase of gold production during the past decade has been owing chiefly to two causes—the abandonment of silver for gold mining on the part of the miners; and the invention of the cyanide process. Both of these impulses have operated upon quartz mining —not upon the placers. Now comes a new and more powerful impulse, a weird invention, a wonderful thing, a "Gold Ship" that moves over the land and that during its strange course extracts



TWO EXAMPLES OF BUCYRUS GOLD DREDGES AT WORK.

The upper figure is the "Cherokee No. 1," owned by the Cherokee Gold Dredging Co.; the lower is the "Continental," owned by the Boston-Oroville Mining Co. The machinery for both was supplied by The Bucyrus Co., South Milwaukee, Wis., while the hull construction and installation was done by the Western Engineering and Construction Co., San Francisco, Cal.

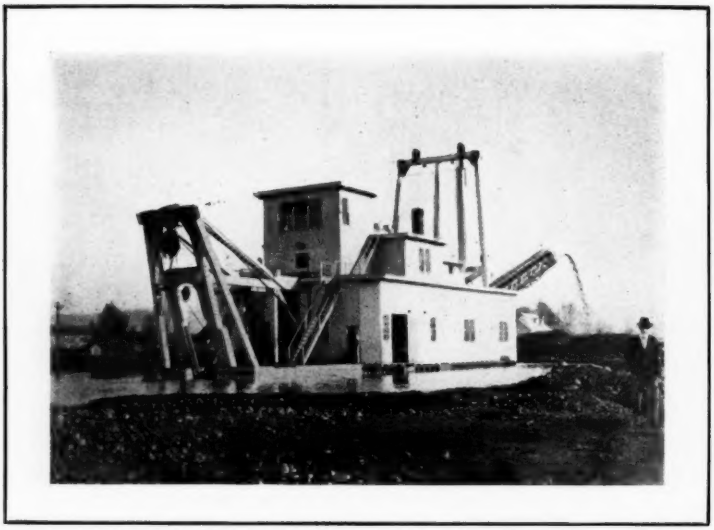


GOLD DREDGE BUILT FOR THE BONANZA BASIN GOLD-DREDGING COMPANY, YUKON RIVER.

Hull 106 by 36 ft.; draught 4 ft.; deck 3 ft. 6 in. above water line; scow 34 ft. 4 in. long; sluice boxes 105 ft. 10 in. long; total overall length 173 ft. 6 in.; will dig to depth of 36 ft.; capacity of buckets 5 1-3 cu. yd.; capacity per day 2,000 cu. yd.; this is the latest type of dredge built by the Allis-Chalmers Company.

every particle of gold out of the long neglected placers, and turns it over to the ship-master. To predict that this machine will double the present product of gold within ten years, is one of the safest of prophecies; it may do much more.

Gold is the most widely diffused of all the metals. There are in California hundreds of square miles—yes, miles—of auriferons, or golden placers, which hitherto have been worked only by hand, or else, being too "poor" to work by hand, while the hydraulic process was practically forbidden by the Supreme Court, have not been worked at all. They contain from 5 to 25 cents in gold to the cubic yard. The gold dredge will extract their entire auriferous contents at a profit, and throw the gold upon the mints of the world. Oregon, Washington, British Columbia, and Alaska possess other auriferons; so do Mexico, Guatemala, Honduras and Costa Rica; so also do Colombia, Equador, Peru, and Chile, especially Peru. I say nothing of Colorado, Idaho, and the other placer fields of Western America. Rich as many of them are, they are relatively unimportant. Greater in extent and richer than any of these are the auriferons of Brazil, Australia, and Siberia. The world is not only going to be saturated with gold; it is going to be nauseated. The Gold Ships will sail over all of these lands and discharge their precious cargoes into the



GOLD DREDGE "EL ORO NO. 1," EL ORO DREDGING CO., OROVILLE, CAL.
Buckets 5 cu. ft. Designed and built by Link Belt Machinery Co., Chicago.

mints. Already are they established in Colombia, New Zealand, and Siberia; a few in each country, soon to be followed by many.

A brief statement of what the principal auriferons have produced from hand labor will perhaps prepare us better to appreciate what they are capable of yielding to this amphibious invention:—

During the 90 years from 1710 to 1800 the placers of Brazil produced by slave labor 750 million dollars in gold.

During the 30 years 1848 to 1878, the placers of California produced, mostly by hand labor, 880 millions in gold.

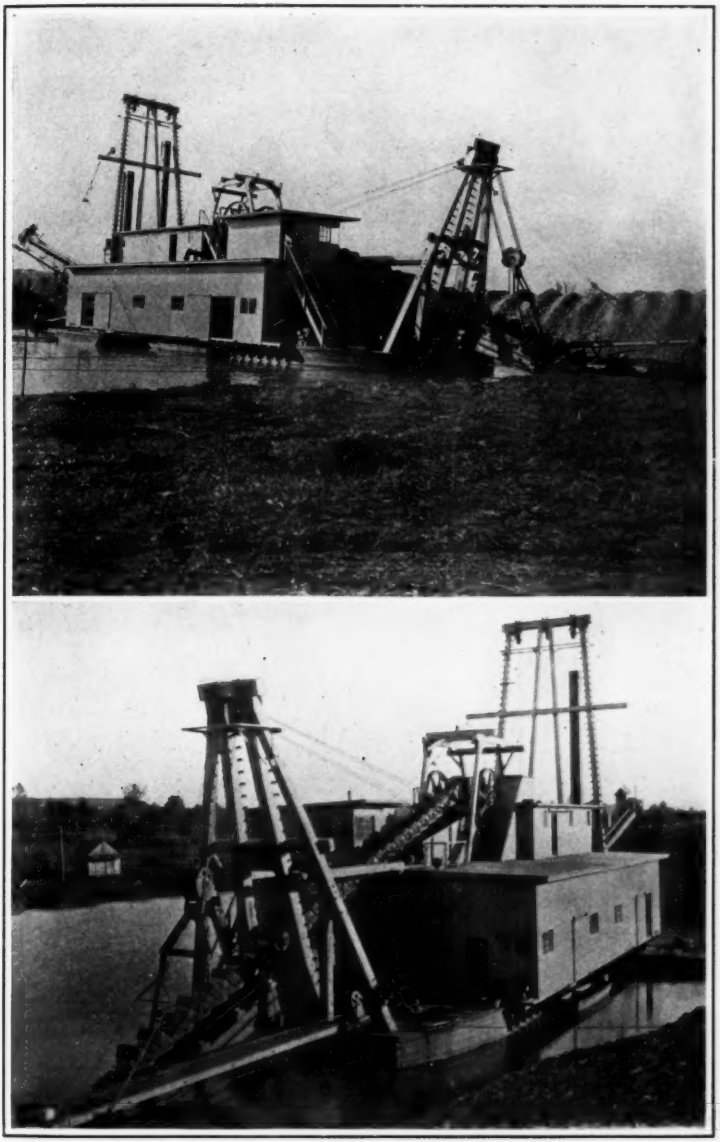
During the 27 years, 1851 to 1878, the placers of Australia produced, mostly by hand labor, 900 millions in gold.*

During the 75 years, 1830-1904 inclusive, Russia produced, largely from the placers of Siberia, 1,300 millions in gold; the present production being about 25 millions a year, and the Gold Ships hardly yet at work.

During the past 10 years, 1895-1904, the placers of Alaska produced, chiefly by hand labor, 140 millions in gold.†

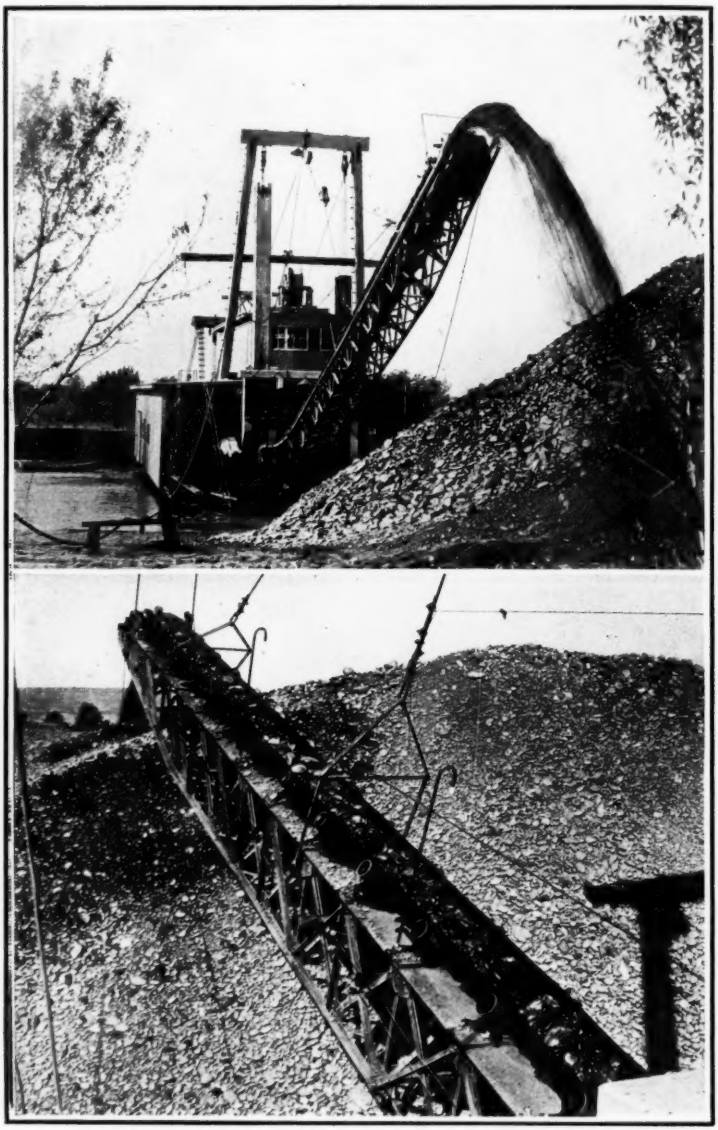
All these placers or auriferons can be profitably worked over by

* *History of the Precious Metals*, 1st ed., p. 124.
† *Ibid*, 2nd ed., pp. 389 and 441 and Supplements.



ELEVATOR DREDGE OWNED AND OPERATED BY THE BOSTON & CALIFORNIA DREDGING CO., OROVILLE, CAL.

The principal dimensions are:—length, 100 ft.; width, 38 ft.; ladder, 78 ft.; stacker, 90 ft.; will dig 35 ft. below water level; 65 buckets, 5 cu. ft. capacity. In Jan., Feb., and March, 1905, averaged 85,450 cu. yd. per month. Built by Marion Steam Shovel Co., Marion, Ohio.



GOLD DREDGE STACKING ITS TAILINGS BY A BELT CONVEYOR.

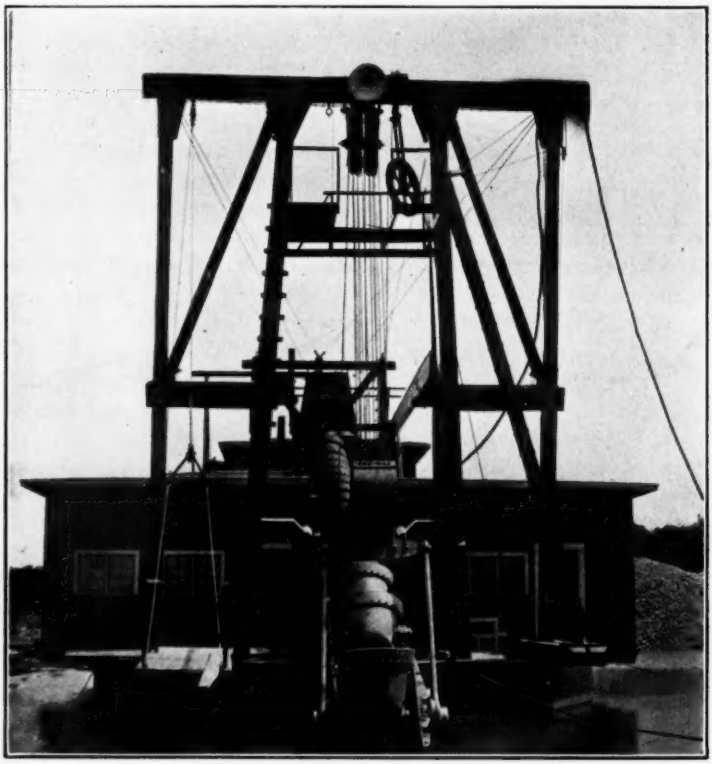
The installation shown is that supplied by the Robins Conveying Belt Co., of N. Y., to the Indiana Gold Dredging Co., Oroville, Cal. The belt is 28 in. by 88 ft. and has a capacity of 250 to 300 tons per hour.

the gold dredge and more gold taken from them than they have already yielded. The reason of this is that hand labor never touches the poorer portions of a placer, and that from the richer portions it rarely succeeds in winning more than from a half to two-thirds of the gold; whereas the dredge gets it all. If we include Spain and Egypt, which still abound in rich placer fields, to say that there are several thousand millions of golden cargo in sight awaiting the Gold Ships, is no extravagance.

Placer mining came to a stop in Egypt and Spain when their product fell to the level of hand labor; it stopped in Brazil partly for the same reason, and partly because the gravel being small and fine, the placer fields are nearly flat, and the mines are "out of grade." It stopped in California because the tailings choked up the rivers and the law courts interdicted the hydraulic process. In Australia it had almost passed the level of hand labor when the gold dredge was invented. In Alaska, though stopped in winter time for lack of running water, it is still going on during the summer time, when the streams are released from frost. In none of these countries was placer mining arrested because there was no more gold in the gravel, but for the other reasons stated, all of which are now remedied by the gold dredge. This invention supersedes hand labor by machinery; it requires no "grade" or declivity down which to sluice its gravel; it will choke no river; it needs only enough water to float itself in and to wash the gold with; and all of this water it can, and does, use over and over again. It is as much at home in the arid but auriferous deserts of Arizona, as in the golden marshes of the Feather River.

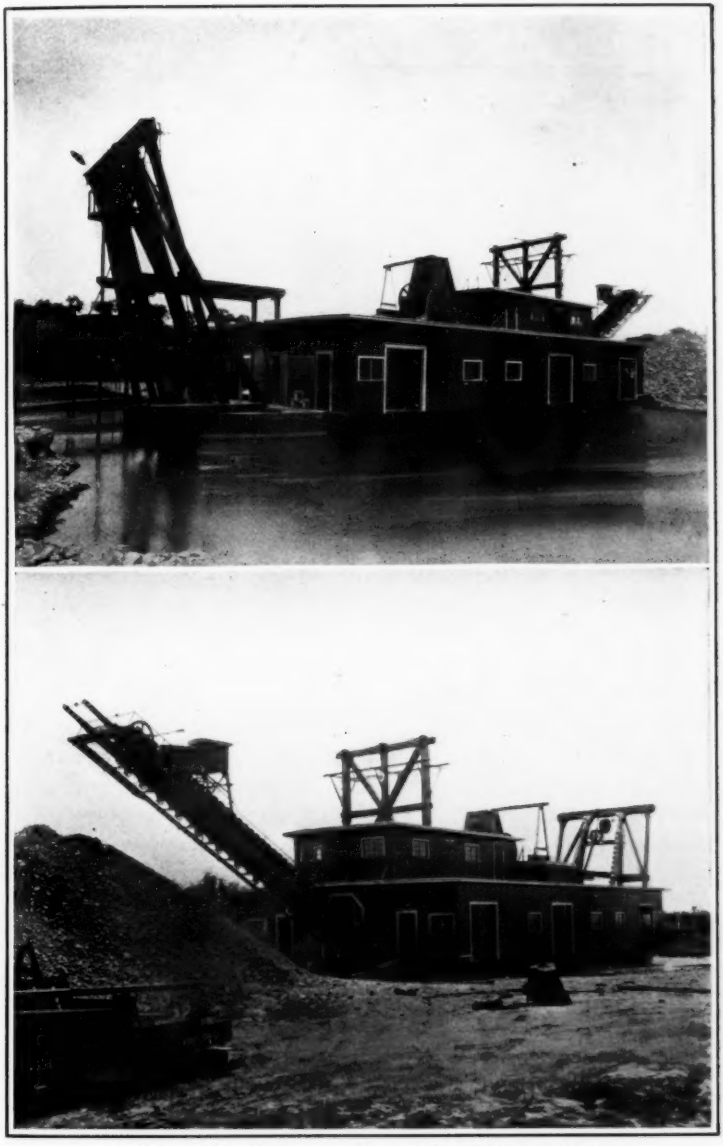
Now let us examine the mechanism of this invention, see how it works, and discuss its probable multiplication and out-turn. The Gold Ship is a dredge, which floats in a pond of its own making, a pond which accompanies it wherever it chooses to go, and which enables it to move over the land in any direction. Thus imbued with volition, it advances to the point of attack, scoops up the gravel, subjects it on its decks to the action of riffles, undercurrents, and amalgamation—indeed, to any desired process, whether mechanical or chemical—and then, having exhausted it of its gold, casts the gravel behind, and keeps on advancing, until the field before it is sifted and treated from surface to bed rock. As the ground can be thoroughly tubed and sampled beforehand, this process lifts gold mining from the category of speculative enterprises to that of a manufacturing business. The gold dredge is a gold manufactory, with an insatiable

demand and assured market for its product, at the rate of $20.17 per Troy ounce fine, paid down by the mints in gold coin. No risk, no idle stock on hand, no bad debts, no commissions, brokerages, or discounts, nor no monopoly of trade, now or ever possible. An instant sale for the entire produce at a fixed price, paid in cash. Such are the incomparable conditions of the gold-manufacturing business. It goes without saying that, unless the cost of taking part in it is beyond the ordinary means of business men, such an industry will not fail to invite a vast number of participants. This contingency can be



A DIRECT FRONT VIEW OF THE RISDON DREDGES ILLUSTRATED ON THE OPPOSITE PAGE, SHOWING THE ASCENDING CHAIN OF 7-CU. FT. BUCKETS.

settled at once. The dredges cost from $35,000 to $50,000 each, according to size; a sum quite within the means of the average business man, commercial partnership, or small corporation.



A RISDON GOLD DREDGE, OF 3,000 YARDS PER DAY CAPACITY.
The upper view shows the ladder end, the lower the stacker. The dredge digs to 35 ft. below water line and stacks 30 ft. above it; buckets 7 cu. ft. capacity. Built by Risdon Iron Works, San Francisco, Cal.

A CHAIN OF LOADED BUCKETS EMERGING FROM THE WATER.
El Oro Dredging Co., Oroville, Cal. The buckets are of 5 cu. ft. capacity, designed and installed by the Link Belt Machinery Co., Chicago.

The gold dredge consists, first, of a wooden scow, 80 or 100 feet long, 30 feet wide, and 7 or 8 feet deep; second, of a medial upright frame, or gantry, and two side gantries, erected upon the deck, all of steel, and carrying the tumbler and countershafts; third, of a series of iron buckets lipped with steel, revolving upon a digging ladder or girder which can be adjusted so that the buckets will attack the gravel bank at any desired altitude within its range—30 feet or more below water level—and carry the gravel up to the grizzlies and screens; fourth, of a series of grizzlies and screens to sift the gravel; fifth, of a series of sluice-boxes, tables, riffles, and undercurrents, supplied with quicksilver, to wash the gravel and seize and detain the gold; sixth, of an elevator or stacking girder, which carries off the stones and coarse material directly, and the fines after they have been divested of their precious burden, depositing the entire lot of tailings 30 feet above water level; seventh, of two centrifugal pumps, delivering 2,000 gallons of water per minute into the screens and boxes; and eighth, of appropriate steam or electrical machinery to perform the entire work and keep the dredge moving on to the

bank until it is entirely worked. All the metal work is housed over. These are the main features; the details can be best understood by referring to the illustrations.

Taking our figures from an actual case, No. 1, in California, the gold dredge erected on the placer ground, provided with thirty-two 5-foot buckets (technically known as a 5-foot gold dredge) cost $50,000; the boarding house, blacksmith shop, and tools cost $2,500; the working capital with which to begin operations, was $12,500; total, $65,000. The cost of operation was $1,400 per month, as follows: power, 75 horse power at $5, $375; master, $130; three winchmen at $90, $270; three deckmen at $75, $225; repairs and depreciation, $400; equal to $16,800 per annum. The annual work done amounted to 10 acres, 30 feet deep, say 500,000 cubic yards, yielding 20 cents per yard, total, $100,000. The profit was therefore $83,200 per annum, or about 128 per cent. on the entire capital invested. This showing is regarded as sufficiently attractive to, in time, turn the eyes of the commercial world towards this extraordinarily lucrative industry. Twenty-cent gravel is not uncommon; neither is 40-cent gravel; there are billions of cubic yards of it to be obtained in

BELT CONVEYOR RUNNING ON THE STACKER OF A GOLD DREDGE.

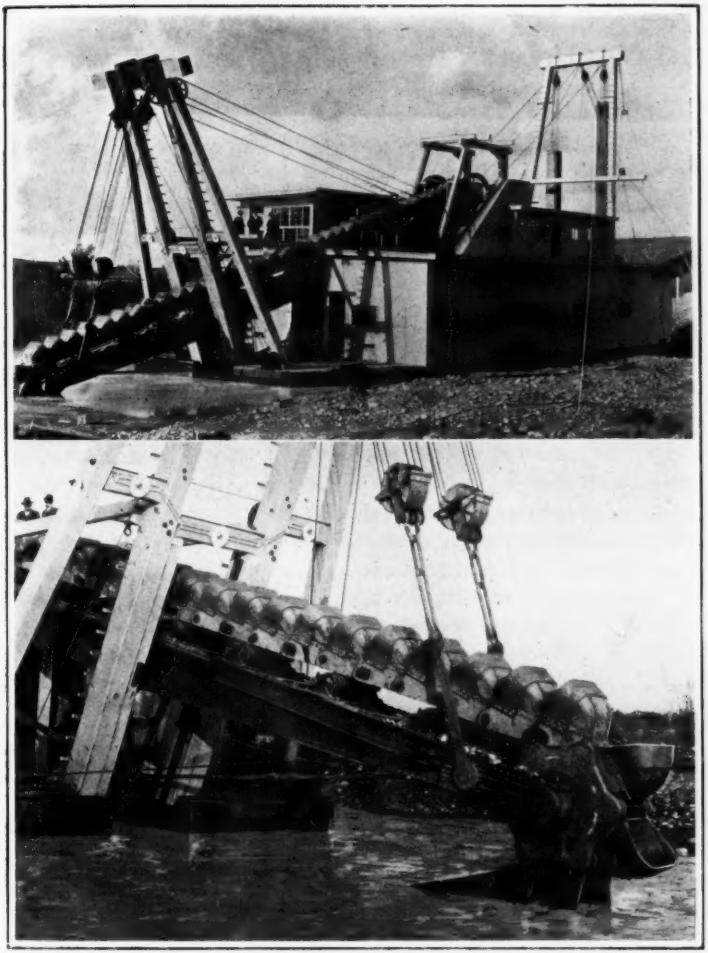
FORGED-STEEL BUCKETS FOR GOLD DREDGE.
Designed by A. W. Robinson.

several countries — Brazil, for instance — and practically for the nominal cost of registering locations.

The theoretical capacity of the 3-1/4-foot dredge is 85 to 120; of the 5-foot dredge, 130 to 190; and of the 7-foot dredge, 185 to 265 cubic yards per hour; while the actual work will depend partly on the nature of the gravel and partly on the skill of the winchman.

Case No. 2 was a 3-1/4-foot dredge, which, during 6,933 possible hours, actually ran 5,752 hours and lifted 297,220 cubic yards, bank measure. The actual expense was:—for wages, $8,400; repairs, $2,250; fuel, $2,660; total, $13,580, or about 4 1/2 cents per cubic yard. Through an economy since perfected, this has been reduced to 3 3/4 cents per cubic yard; so that gravel containing so little as 5 cents to the cubic yard will pay to work, and yield a sure profit of 33 1/3 per cent. In using steam machinery, the 3-1/4-foot consumes about 2 1/4 and the 5-foot dredge about 4 cords of wood per diem, for fuel. Theoretically, the cord measures 8 by 4 by 4 feet; but practically, especially in mining regions, it is 6 by 4 by 4 feet. The ton means 2,000 pounds.

The weight of the machinery necessary to construct and set up a 3-1/4-foot dredge is about 120 tons, including all the bolts,



DREDGE CALIFORNIA NO. 2, BOSTON & CALIFORNIA DREDGING CO., OROVILLE, CAL.

A 5-cu-ft. dredge of Bucyrus build. The lower view shows in detail the chain of buckets. They have manganese-steel lips and bushings, cast-steel bases, forged-steel pins. The tumblers are of cast steel, with manganese-steel wearing plates. The ladder rollers are manganese-steel. Manufactured by the Taylor Iron & Steel Co., High Bridge, N. J.

screws, spikes, nails, and other metal-ware necessary for the purpose; in short, everything except the lumber, or woodwork. The quantity of lumber required equals 50,000 to 60,000 feet, board measure, and weighs about 75 tons. The machinery for a 5-foot dredge weighs about 200 tons and the lumber about 150 tons. The repairs which might be needed for the smaller machine can be executed by a blacksmith; while those on the larger ones would need the aid of a machine shop. The freight from the American port of shipment depends, of course, upon the port of debarkation and distance to the placer ground. Insurance is equally indeterminate. In most countries, machinery to develop the mines is free of duty, and the mines themselves are free of taxes or other dues. With these details before him and the services of an experienced placer miner to test and afterwards to work the gravel, any merchant, with the requisite capital, can at once become a profitable producer of gold.

Like most other inventions, the Gold Ship is a development. A gold dredge was used on the Magdalena River twenty years ago; the device was further developed several years later in New Zealand; it was brought almost to perfection in California; at the present time, a dozen machine shops, scattered all over the United States, are rivalling one another in turning out a more and more perfect dredge. The home demand for these machines is so urgent that but few have as yet been shipped abroad; yet several of them have already gone to South America and several more to Europe. The present rate of out-turn is about one machine per week; in the course of a few years it will be one per diem; in ten years it will probably be ten machines per diem. When this takes place, and perhaps before it, the world's production of gold, even should the quartz mines yield no more than at present, will be two million dollars a day.

When, during the sixteenth century, the mines of America threw upon the world a vast and unlooked for supply of the precious metals, the result was to impart a sudden and tremendous stimulus to production, invention and discovery. The Halcyon Ages dawned; and Europe rose at a bound from penury, ignorance, and retrogression, to comfort, enlightenment, and progress. That such may be the bright future before us of today, nothing seems wanting but to let the Gold Ships pursue their eventful voyages in peace.

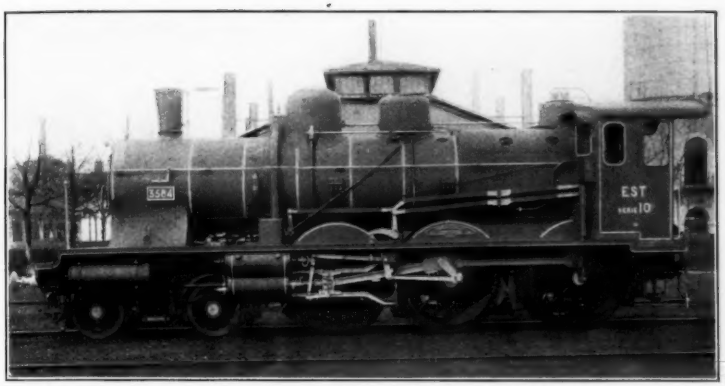


FIG. 1. SPECIMEN OF LOCOMOTIVES BUILT AT EPERNAY.

Fast-freight or mixed-service engine, "Est" type; four cylinders, piston valves to all; Walschaert-Heusinger valve gear; air brake on front truck.

A LARGE LOCOMOTIVE BUILDING AND REPAIR WORKS IN FRANCE.

By Charles R. King.

The railway locomotive shop offers many opportunities for the application of the latest ideas in tool practice and general management, and Mr. King's articles would be widely interesting if only for the examples of this kind they furnish. The recent International Railway Congress, however, has greatly stimulated the home interest in foreign practice, and as a most timely contribution to this important study we are glad to offer these two papers, describing in valuable detail the methods and the work of one of the most advanced establishments on the Continent. The first of the group, presented in this issue, deals chiefly with the general arrangement and equipment of the works; the following section will review the locomotive-erection and general machine-shop practice of the Epernay shops.—THE EDITORS.

AT a time when the locomotives of France are attracting the attention of American and English constructors, some description of an important railway works devoted to the making and upkeep of such machines may have especial interest for mechanical engineers.

The works of the Chemins de Fer de l'Est are especially selected for mention here, for the reason that while nearly all locomotive-construction for French railways is in the hands of private firms, this railway company has for a great number of years past built many of

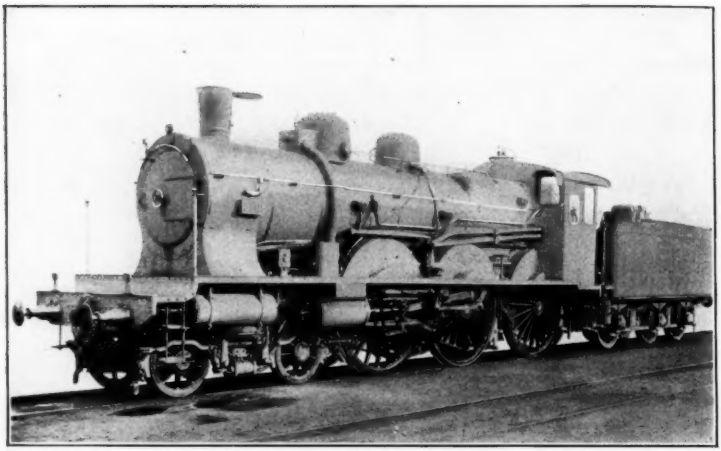


FIG. 2. "EST" TYPE 6-10 COUPLED LOCOMOTIVE.
Four-cylinder compound, "Est" system; de Glehn starting valve.

its own locomotives, and while keeping abreast with modern developments has maintained more individuality for its mechanical productions than other French lines. Here it may be remembered that the heads of the "*Materiel et Traction*" of the Est are engineers of great ability who have been known throughout the railway world for a long term of years—that is, M. Salomon and his chief mechanical engineer, M. Flaman—men of that genius and high cultivation which appear to be characteristic of chief railway engineers in France.

The company's works are situated at Epernay (Marne) on the main line between Paris and Nancy. They are interesting both for their extent and for the wide range of work done in the shops. Although the shops themselves are not all wholly modern, as are those of the Nord company at Hellemmes-lez-Lille (Nord), the all-important matter is that the tool equipment is modern. With the "Est" all locomotive building and repairs are concentrated at Epernay, whereas the "Nord" has a central works at Paris-la-Chapelle where a certain amount of heavy work is done, including an occasional "type-locomotive." On the contrary, the Central works of the Est at Paris-Pantin are principally confined to car repairs, the main car-building works being situated at Romilly on the Paris-Belfort trunk line.

The extent of work done at these Epernay workshops may be gathered from the fact that the number of locomotives to keep in

repair (at the beginning of the year 1904) is 1,422—of which number there are 212 four-cylinder locomotives of the 6-10 connected type, some 50 of which are employed for freight haulage. A view is given in Figure 1 of this mixed-service type having a piston valve for each of the four cylinders, and built at the Epernay works, besides one of the most recent 6-10 connected type for the fastest trains also built at Epernay (Figure 2). This latter, it will be seen, has flat slide valves; but later engines are to have piston valves also.

The total mileage of the company's locomotives in the year 1903 was 36,370,000 miles, and the number of locomotives which entered the shops for important repairs was 108—all small jobs being done as usual in local running-house repairs sheds. The average time-duration, out of the total number of repairs executed, is usually from 4 to 5 months.

The number of new engines built in one year (1903) is 30. The number of workmen employed is 1,500. The motive power required for the works will be found described in the details hereafter given.

As usual with a great many European locomotive works which are not entirely of modern origin, there are at Epernay various buildings which have been built in accordance with the necessities of the period, each one having been all-sufficient in its own time; but as the steam locomotive grows in size each year to answer the requirements of ever-increasing populations, even comparatively modern works have been outpaced by its bulk and its weight. In general, it is the erecting shop which receives the first care for the necessary enlargements—and this has been the case at Epernay.

The situation of the workshops is between the Epernay station and the river Marne; but before proceeding to the new erecting shops we may look into the boiler house and power room which, though not remarkable for their size, are interesting for their plants. In fact, just before entering the boiler house, the visitor's attention is attracted by the sight of long banks of roasted coal or cinders lying outside its doors. These are the screenings of locomotive smoke-box residues which are always used for generating the power required at the works. One locomotive, on average, yields 660 kilograms (1450 pounds) of these screenings per month, but the calorific value of this product does not appear to have been so far tested. The analysis, however, shows its contents to be as follows, as compared with the ordinary coal used—which latter is a small or slack coal of "*demi-maigre*" quality capable of generating 6 pounds of steam per pound of fuel:—

	Smoke-box sweepings.	Fine coal (slack).
Carbon	66	65
Volatile matter	4	15
Ash	22	18
Water	8	2
	100	100

The smoke-box residues generate 3 1/2 pounds of steam (effective) per pound of fuel, after making deduction for the amount of steam used for the furnace blower jets, and this result, it may be remarked, is at least equal to that produced by the poorer kinds of the lignite, or brown coal of Bohemia.

In the boiler house there is one row of six water-tube boilers built by the Epernay works, fitted with moveable tubes on the Berendorff system, this form of generator having two parallel boilers at the base connected by straddled rows of side tubes to a steam cylinder (usually misnamed a "drum") at the apex. The boiler pressure is 108 pounds per square inch. The annexed view, Figure 3, conveys some idea of the type of generator employed. The three farthermost boilers were, at the time of making this photograph, fed with ordinary coal, and the three nearest boilers were fed with locomotive smoke-box screenings, the steam pipes for blowing the grates being visible in the details. The grates, of an Austrian system (the Kudlicz), are cast-iron panels, the air spaces being round conical holes and the ash pan beneath them being perfectly air-tight. In the front of the ash pan there are eight steam tuyeres or jets, that is, four beneath each lower barrel of the generator. The steam blast entering below the grate maintains the cinders or roasted coal in a state of high incandescence. From 5 to 10 per cent. of the steam produced is used for blowing the grates. At present (1904) smoke-box sweepings have entirely replaced the coal hitherto employed. The grate area of each boiler is 33 1/2 square feet, and the heating surface 1,300 square feet. The evaporation is from 2,000 to 2,400 litres per hour. The boiler-house chimney has a height of 140 feet and a diameter inside of 6 feet 6 inches, its foundations being built on piling.

In the adjoining power house the engine is a single-expansion condensing machine of Corliss type, made by Lecouteux & Garnier, developing 250 horse power and having an efficiency of one horse power per hour for 16 1/2 pounds of steam. Its cylinder is 24 inches diameter, with a piston stroke of 4 feet, and is steam-jacketed. When working at full load the cut-off is 1/16. The expansion valves provide admission up to 8/10 cut-off point, when required to develop

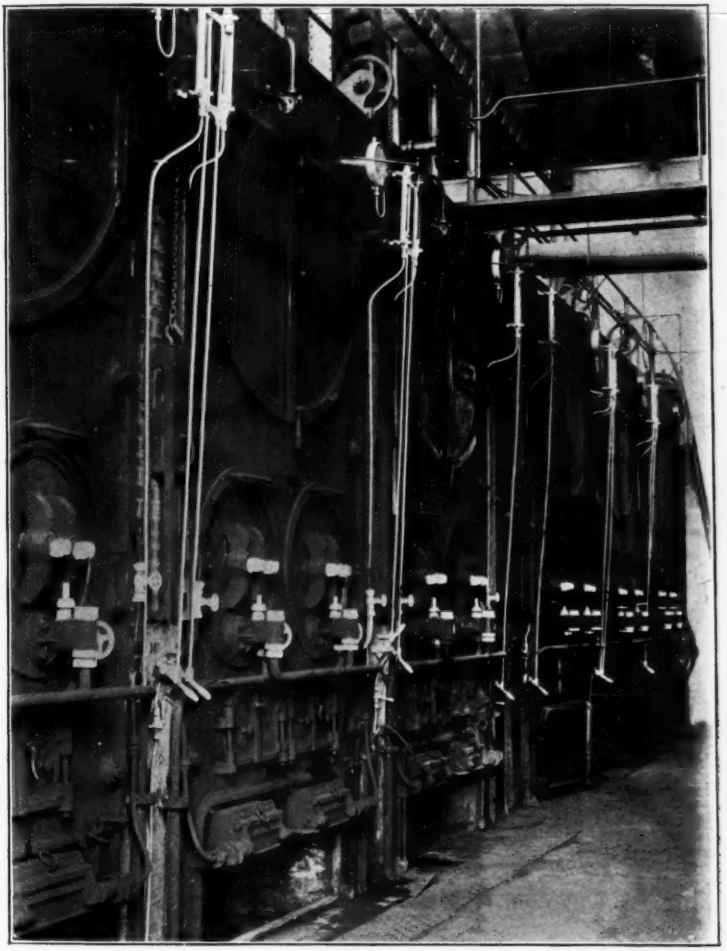
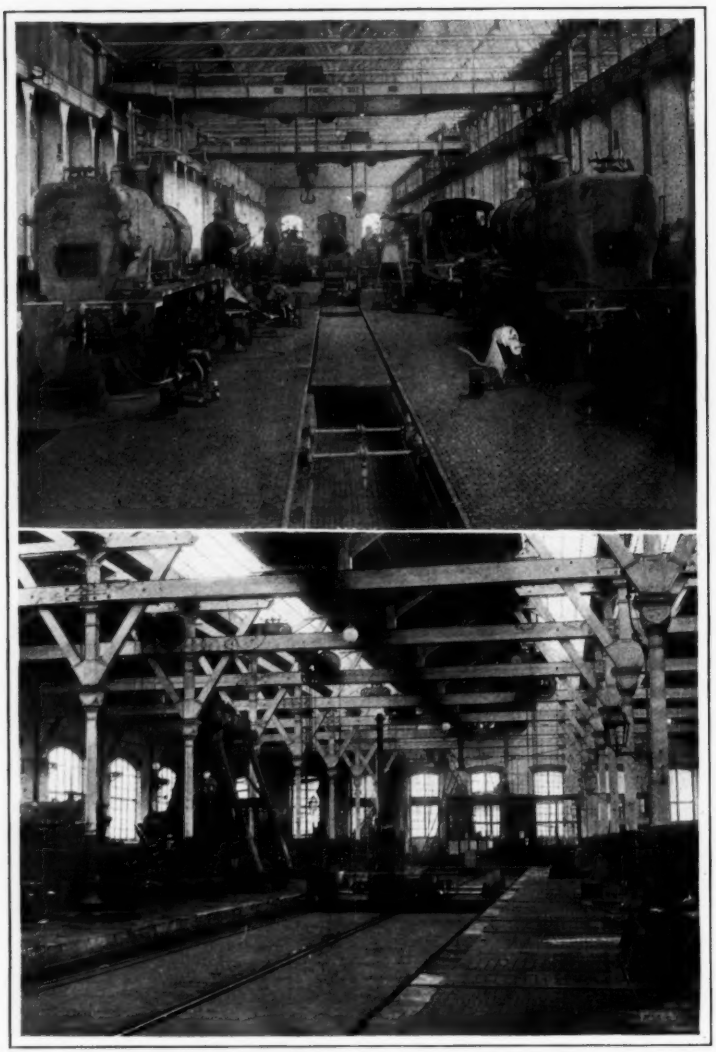


FIG. 3. THE BOILER PLANT.
The three boilers in the background are fed with coal, the three in the foreground with locomotive smoke-box screenings.

more power or when working non-condensing, as in the case of stoppage of the condenser for any reason. The steam condensed in the jacket is drained direct to the feed water, which latter supply is derived from the river Marne, 180 metres distant. The pumps, driven from the engine main shaft, have a capacity of 9,000 litres per hour—



FIGS. 4 AND 5. FIGURE 4, BELOW, IS THE ERECTING SHOP WITH DEPRESSED TRANSFER WAY. FIGURE 5, ABOVE, SHOWS A LONGITUDINAL TRAVERSER IN THE ERECTING SHOPS.

sufficient for all requirements of four out of the six boilers in service at one time. The boilers are provided with two Sellers injectors (9 and 9½ centimetres) with a capacity of 9,000 litres per hour. The temperature of the feed water is 30 to 40° Centigrade, but in winter-time the heating-coils in the erecting shop are drained into the feed water and its temperature is thereby raised to 70 and 80°; the feed is then worked by a Blake double vertical pump, fixed near to the boilers and having a capacity of 6,000 litres per hour.

The engine fly-wheel has a diameter of 16 feet 4 inches; it has twelve drive-rope grooves and turns at 60 revolutions per minute. It has a barring attachment for starting it from dead centers. Being situated next the new erecting shop, direct transmission by belt is employed for the heavier kinds of tools usually necessary in such a department, and as these are grouped near to the power house, a minimum of shafting is necessary.

Electrical Power Transmission.—In considering the advantages of electrical transmission, it was estimated that with new and well made motors the electrical output at full load would be 0.9 and the effective electrical transmission $0.9 \times 0.9 = 0.81$, while with a small load and with machines of low power the efficiency would rarely be less than 0.5. The saving to be effected by electrical transmission would amount to 17 tons of shafting and the power necessary to drive it, light load or heavy load, all day long. The machine adopted for the service is a six-polar dynamo of 600 amperes at 110 volts tension, variable by rheostat between 100 and 120, and having an efficiency of 92 per cent with full load.

Erecting Shops.—The several views given show the old as well as the modern erecting works. The old one, built in 1877, Figure 4, has a traversing pit with steam traverser, the inconvenience of which arrangement is that the space allowed for the length of locomotives in the various bays cannot always be economically utilized, by reason of the widely-varying lengths of the different types of locomotives to be housed. The traverser pit is also an impediment to the workmen, who have to cross it frequently, and when carrying pieces which, though heavy in themselves, are too light to warrant the use of a crane. Of course a shop of this type need not have this objection of a sunk floor, for there are many modern shops with a level floor where an electric floor traverser is used, this latter being of course raised and provided with suitable inclined ends for hauling aboard the machines to be transferred. The old shop accommodates sixteen locomotives in eighteen bays (two bays being reserved for

semi-portable engines and boilers), while the new one has a capacity for fifty-six locomotives—the total therefore of the two shops being seventy-two locomotives. The new shops, Figure 5, were designed by the Est permanent-way department, partly upon the model of those already existing at Romilly, and were built in 1894. They are constructed entirely of steel and of fire-proof materials; their roofs, of lean-to or shedding pattern, being in two spans and lighted exclusively from the north side. Each of the two bays so formed comprises three tracks, two for erecting and one through line for transits. The side lines accommodate a total of forty locomotives, and the two central lines in case of necessity can also be used for work of a temporary character and so accommodate sixteen locomotives.

Two cranes of 30-tons (metric) lifting power serve each of the two bays and are sufficient to lift a single locomotive of the present "Est" type from one track to another, or out of the shop when the engine is not loaded up with all its fittings (see view Figure 6). These cranes, by Merlot, are driven by steel-wire cables having a hemp core. All their gears are controlled from the usual operator's platform, but as the work done consists largely of repairs it is not always convenient to keep an attendant there for that purpose; consequently hand chains are also provided, by which the raising, lowering, and traversing motions may be controlled from the shop floor itself. Pinions are used throughout for driving gears, in place of worm screws which would absorb much more power. Gearing or ungearing of the pulley is effected by shifting a belt from a fixed to a loose pulley, this change being operated by means of a small auxiliary worm screw driven by cord. Changes of speed can also be effected from the floor, the chain for this purpose passing over a fixed pulley on the crane beam. The raising and lowering gear includes a special ratchet device inside the pulley of the grab hooks, the brake therein being automatic, while the controlling brake-lever of the crane renders the ratchets, or safety clutches, inoperative only so long as the grab block is on its downward course. Both cranes can be operated together as though one piece, and all the fast movements can be employed simultaneously for loads of up to 15-tons weight.

The lineal speed of the cables is 15 metres per second, the traveling speed of cranes 8 to 20 metres per minute, the traversing-crab speed is 4 to 12 metres per minute and raising and lowering speeds, 1 to 2½ metres per minute. The total crane travel in the shop is 156.4 metres. The crabs have a traversing movement of 11.5 metres and the control-chain carriers, or trucks, have a travel of 5½ metres.

These trucks are provided one for each gangway on each side of the central track, and their chains always hang within reach of the workman or in such position as enables him to get the best view of the piece that is being lowered into place. The clear height of the crane beam from the floor is 7.6 metres.

FIG. 6. TWO OVERHEAD TRAVELING CRANES CARRYING A LOCOMOTIVE IN THE ERECTING SHOP.

Portable rolling frames with electric motor for operating drilling tools, etc., are shown in the right foreground.

The forms of transmission employed in the shops are belting, cable, compressed air and electricity; hydraulic transmission having a very limited application. Transmission of current to small tools is effected by wires laid in conduits along the side walls of the track pits, the number of openings provided for the wire connections to the tools being very large throughout the whole length of the shop. As the number of portable electrically-driven machine tools used at these workshops is very large, little more than a summary notice of them can be given here. There are forty-four complete sets of portable electromotors aggregating 128,142 watts or about 174 steam horse power. When hauling cold locomotives about the shops and where lifting is not necessary, electric winches are used, these being made fast to the rails by suitable grips on the main frame of the appliance

and upon which latter is mounted a motor of about 4 horse power, speed being reduced from the motor shaft to the pinion shaft of the winch by means of a belt (see Figure 7).

For drilling purposes the types of machines are many. Those for stay-bolt holes in fire-boxes are very small, compact machines readily fixed to a wooden beam bolted across the crown of a fire-box. By means of a long radiating arm with telescopic shaft, any part of the side sheets or boiler head can be reached very conveniently. Such a machine may be noted in the view Figure 8. The same pivoting arrangement, but without the motor case as a means of support, can be attached, inverted, to a roof-girder or wall-plate, and then serves also for drilling crown stays. Drilling, reaming, tapping, and screwing in bolts is the common work of these machines, both in the boiler shops and erecting shops. They are fitted with Gramme motors of 2.3 kilowatts or about 3 horse power.

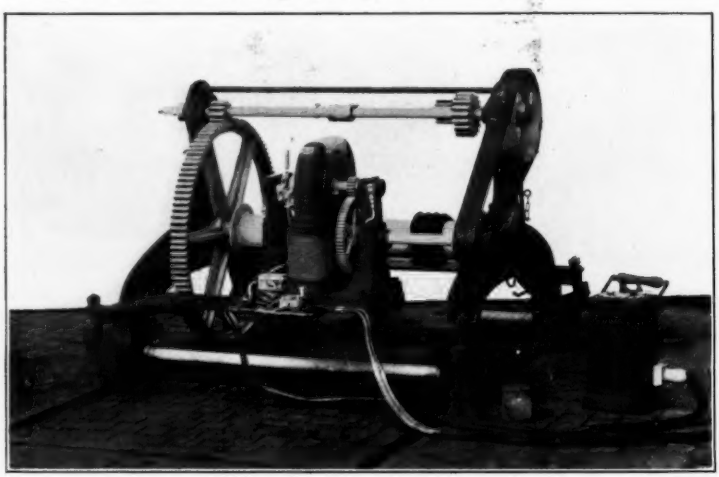


FIG. 7. ELECTRIC WINCH FOR HAULING LOCOMOTIVES, IN THE ERECTING SHOP.

For frame-drilling, where one or more plates, including sometimes the horn-blocks or "pedestals," are to be pierced, different forms of fixings are employed for the tool in order to suit the nature of the work in hand, and as may be discerned in the views Figures 5 and 8, the transmission being either rigid or elastic and the motors mounted on a two-wheel barrow or upon four rollers. These all have Gramme motors of 3 horse power.

A universally handy appliance for frame-drilling and for drilling

certain parts very difficult of access, consists of a portable frame or tower on wheels, to the base of which is attached the electromotor, while the head carries the shafting and pulleys for belting, any desired variation of speed being effected through grooved pulleys and driving cords. This rolling stand may be used for any other drilling rigs that are not provided with their own special motor. This may be seen in the middle of the view Figure 5 and in the foreground of the view Figure 6. The motors employed are of Postel-Vinay type, of 4.6 kilowatts or 6¼ horse power.

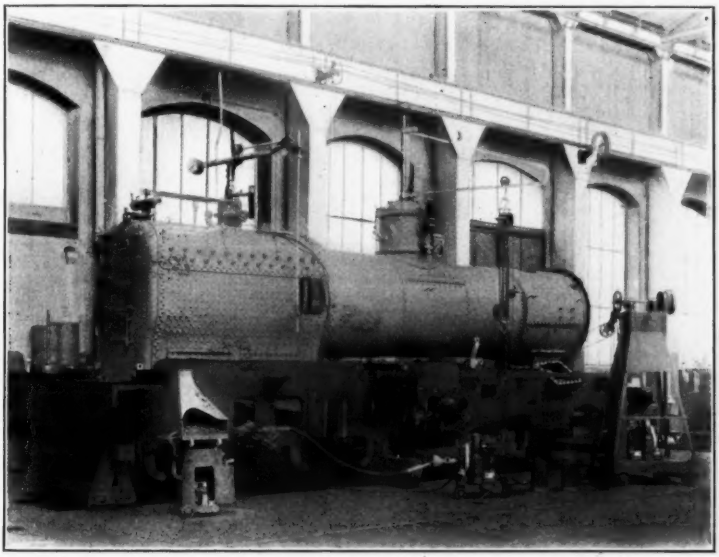
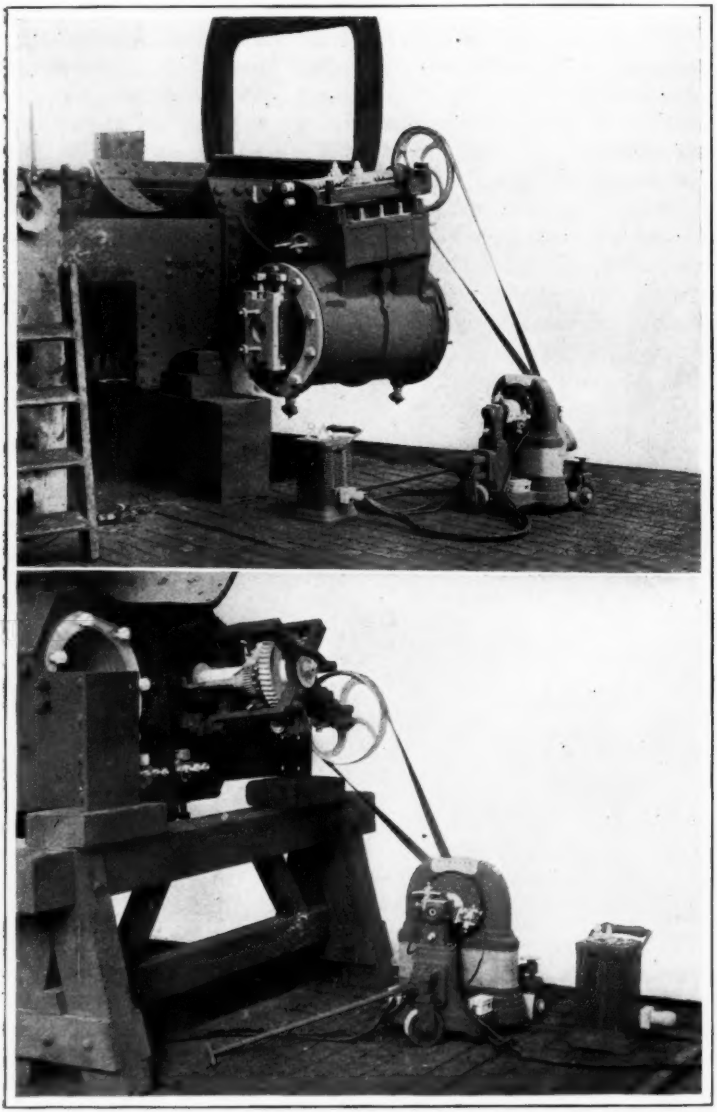


FIG. 8. THE ERECTING SHOP. ELECTRICALLY DRIVEN PORTABLE MACHINE TOOLS AT WORK.

The drilling machines with long radiating arm and telescopic shaft are adaptable with great convenience to drilling any part of the side sheets or head.

For reboring a cylinder or surfacing a worn valve-seating, the appliances shown in Figure 9 and Figure 10 are used. The cylinder borer is secured by means of the usual cover bolts in the place of the covers themselves, the mandrel imparting the rotary movement to the boring head, while two fine screws, passing through the latter and revolving with it, give the necessary feed to the cutters. This is shown in Figure 9, wherein it may be noted that the boring head is already advanced two clear inches into the depth of the cylinder. This rig is driven by a Gramme motor of 3.3 kilowatts and a similar ma-



FIGS. 9 AND 10. FIGURE 9, BELOW, ILLUSTRATES THE OPERATION OF CYLINDER BORING BY A PORTABLE TOOL. FIGURE 10, ABOVE, SHOWS PORTABLE APPARATUS FOR FACING THE VALVE SEATS IN PLACE. BOTH TOOLS ARE ELECTRICALLY DRIVEN.

chine serves for the valve-seating milling-tool shown in Figure 10. In this case the feed is provided through the screw and pinion gearing on the main shaft, which carries the driving pulley connected by belt to the motor shaft.

This reboring machine can, on an average, finish a cylinder complete within five hours, while the valve-seating miller can dress up a seat anew in about four hours upon average.

In the same erecting shops the portable forges are provided with electromotor-driven fans as shown in the view Figure 8. Fixed to brackets bolted to the roof columns there are about eight electromotors of 2.8 kilowatts for driving, by belt, double-head emery surface-grinders, and three others for tool-grinding wheels. All the motors in the shops have a commutator carrying a metallic rheostat only serving for purposes of starting the machine. The portable machines, however, have pinions for reducing the speed to 300 revolutions per minute on the tool-shaft, but the speeds can be further varied by rheostat to suit individual tools or the particular work in hand.

In the end of the same shop the heavy tools provided are a Grafenstaden radial drill of 1.7-metres sweep; a Bouhey borer and drill; a Warrall pedal drill; a Ducommon planer; two Marsden shapers; a Bouhey circular shears; two Nathan-Khan stone-grinders —one "edge" and one "face"; a Root's blower for a double forge, and various smaller tools.

The fitters' benches, arranged around the sides of the shop, are provided with nettings about 80 millimetres high for the purpose of arresting flying pieces of metal. Racks are provided where the cutting tools belong to each machine are placed after being cleaned and washed.

A following article will take up the methods used in locomotive erection in the Epernay shops, and the general machine-shop management and administrative policy of the works.

The Engineering Magazine

DISTRICTS IN WHICH BRITISH TRADE PREDOMINATES
" " " GERMAN " "
" " " AMERICAN " "

A GRAPHIC CHART OF BRITISH, GERMAN, AND AMERICAN DOMINANCE IN EXPORT TRADE.
The trade-zone numbers correspond with those used by Mr. Digby in the body of his article.

ENGINEERING EXPORTS OF GREAT BRITAIN, GERMANY AND THE UNITED STATES.

By William Pollard Digby.

II. RELATIVE PROMINENCE IN THE MOST IMPORTANT TRADE ZONES.

Mr. Digby's analysis of trade supremacy began last month, with a general review of export figures. It will conclude next month with a forecast of future changes. Throughout, it gives a remarkably graphic idea of the world-wide markets for engineering manufacturers. —THE EDITORS.

ADJOINING the European countries, which were treated as a composite trade zone in the last number of THE ENGINEERING MAGAZINE, is a group of countries comprising northern Africa, Egypt, Algiers, Tripoli, Morocco and Asiatic Turkey, ranged around the southern and eastern Mediterranean seaboard. This zone, while covering a larger area, has but a sparse population, and offers only a limited market to the engineering manufacturer. Egypt, whose resources are now being developed in a great number of directions, makes the chief purchases. Continental countries are regarding this zone very jealously, and there are the elements of international complications over the "pacific penetration" of Morocco, or the apportionment of the dominions of Abdul Hamid should the Turkish Empire go to pieces. Whether any of these regions are potential Egypts remains to be seen. Judged by the present amount of trade in certain parts of this region, it seems strange that so much attention should be given to the virtual staking out of claims for posterity. Surely no other power hopes to emulate British performances in Egypt, a country which, at one time the granary of the world, seems likely to regain a portion of its past eminence by reason of the fruits of the Nile barrage.

The following are the value of the exports from Great Britain, Germany and the United States to the countries mentioned in this region:—

EXPORTS TO ZONE 2.—SOUTHERN AND EASTERN MEDITERRANEAN SEABOARD.

Year.	1899.	1900.	1901.	1902.	1903.
Ex	In thousands of pounds sterling.				
United Kingdom	891	964	849	971	927
Germany	...	277	385	440	575
United States	35	43	123	29	23

The British predominence is due largely to the extent of the exports to Egypt. The chief items of the British and German trade to Egypt are shewn in Diagram No. 1, which shews a decline in

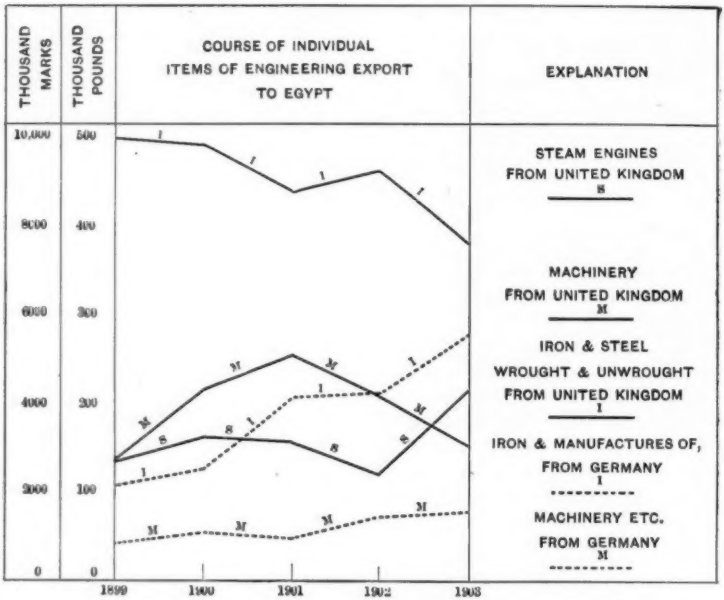


FIG. 2. ITEMIZED CHART OF ENGINEERING EXPORTS TO EGYPT.

the exports from the United Kingdom of iron and steel goods as against an increase in the exports from Germany of iron and iron wares. The British exports of steam engines reached their highest German exports of machinery increasing slightly. Asiatic Turkey is growing in importance as an engineering market, as shewn by the following figures:—

EXPORTS TO ASIATIC TURKEY.

Year.	1899.	1900.	1901.	1902.	1903.
Ex	In thousands of pounds sterling.				
United Kingdom	75	82	85	97	110
Germany	..	77	143	138	179
United States	16	104	75	61	29

While the exports from the United Kingdom have continuously increased, they were surpassed in value by the German exports in 1901 since when they have held second place. The American exports have fallen persistently since 1900.

British East Indies.—Passing eastward around the world, the next large trade zone calling for attention is that comprising Aden, British India, Burmah, Ceylon, and the Straits Settlements. To the British manufacturer it is of considerable importance as is indicated by the following figures of total trade:—

EXPORTS TO ZONE 3.—BRITISH EAST INDIES.

Year.	1899.	1900.	1901.	1902.	1903.
Ex	In thousands of pounds sterling.				
United Kingdom	7,449	7,740	7,209	7,620	7,619
Germany	....	722	1,054	880	1,334
United States	256	301	470	229	139

The chief factor in regard to India's demands for general engineering as well as commodities is undoubtedly that of the presence or absence of a sufficiency of food stuffs for the vast population of 300,000,000 people. A failure of the monsoon results in diminished crops; revenues tend to fall; the peasant who lives through the stress of famine has little wealth available for the purchase of, say, cheap cotton stuffs. There being no crops to be transported, the railways in the affected regions do not need to indent so heavily as usual for

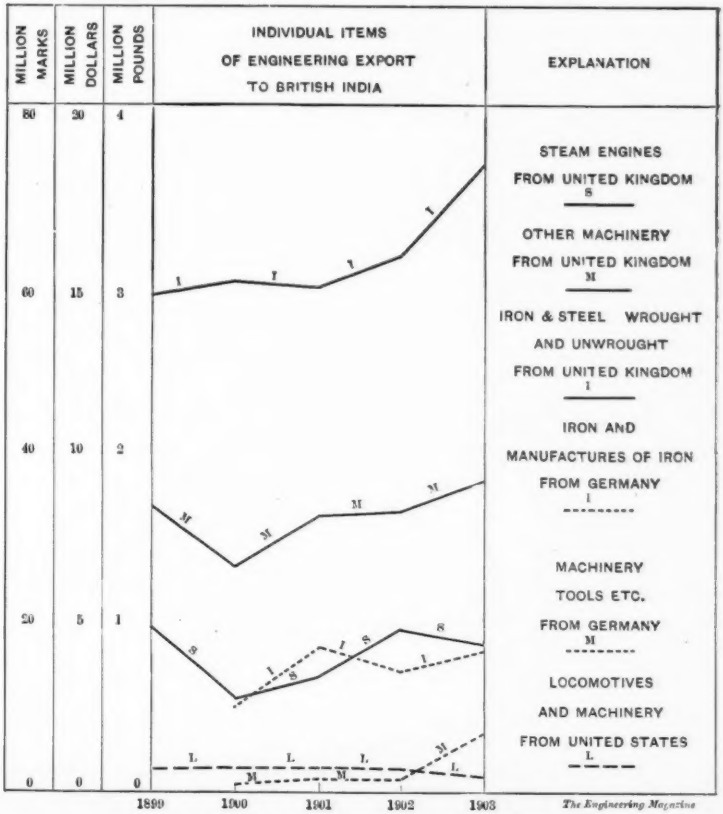


FIG. 2. CHANGES IN THE PRINCIPAL EXPORTS TO INDIA.

stores, or rails, or rolling stock. The foregoing figures do not show the full effect of the last famine in the British trade with India in engineering commodities. A reference to Diagram No. 2 shews the recovery in regard to three main classes of British and two of German exports after 1900. Although the scale of this itemized diagram is a fairly large one, it does not suffice to show clearly the amounts of the American trade under its chief headings. One curve only is shown of American exports (of locomotives and machinery) and this applies not to British India but to the whole of this zone. From a comparison of diagrams, it will be observed that the British exports of machinery other than steam engines to British India, exceed the combined German and American trade to this zone as a whole. American exports have declined in regard to steel rails, structural iron and steel, locomotives, and general manufactures—indeed, in 1903 the trade in the first three of these items was non-existent. A decrease in the demand for locomotives caused a retrogression in the British exports of steam engines in this year. As regards other materials there were extensive exports of textile machinery, millwork, railroad materials, tinned plates, and so forth.

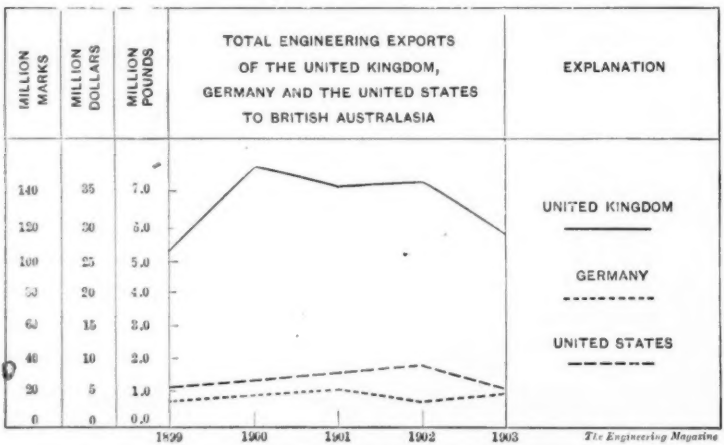


FIG. 3. SUMMARY OF TOTAL EXPORT TRADE TO AUSTRALASIA.

British Australasia.—The continent of Australia which, together with Tasmania, New Zealand, and the Fiji Islands, forms the fourth zone in our discussion, is sufficiently remote from the three chief manufacturing countries to place them practically on a parity as regards freight charges, a slight advantage resting with Great Britain and Germany. In this region, again, British trade largely predom-

inates, as is shown from the following summary of the total trade illustrated in Diagram No. 3.

EXPORTS TO ZONE 4.—BRITISH AUSTRALASIA.

Year. Ex	1899.	1900.	1901.	1902.	1903.
	In thousands of pounds sterling.				
United Kingdom	5,080	7,701	7,194	7,393	5,971
Germany	767	941	1,113	845	950
United States	1,094	1,477	1,654	1,874	1,220

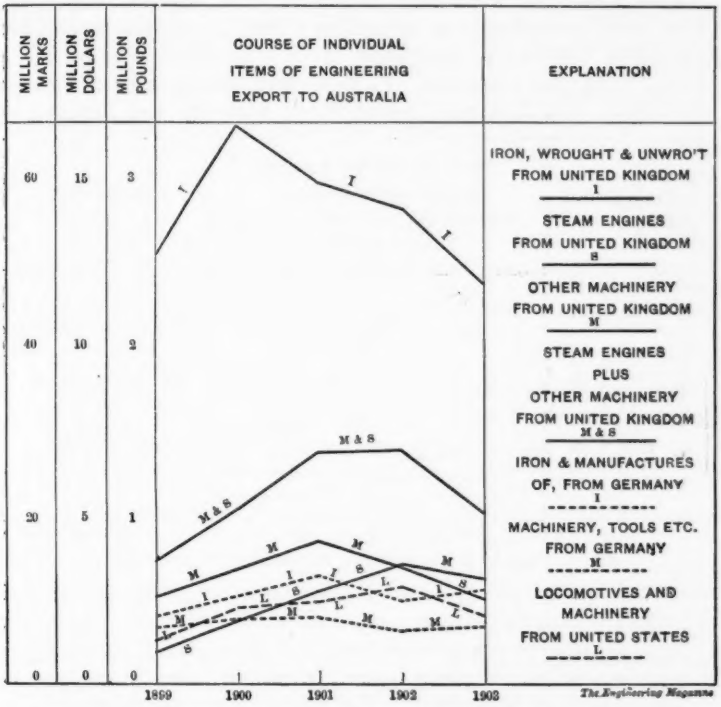


FIG. 4. FLUCTUATIONS IN LEADING ENGINEERING EXPORTS TO AUSTRALIA.

Taking Australia (and Tasmania) separately, the fluctuations in the leading items imported are shown in Diagram No. 4. In this diagram the fall in British exports of wrought and unwrought iron and steel goods is clearly marked. There has also been a German decline of smaller extent. A falling off in the rate of railway extensions is partly responsible. The adverse climate conditions of the severe drought affected the machinery exports of the three countries in 1903. For Germany it will be seen that a single curve marked "M" represent the imports of all kinds of engines and machinery, but that

for the United Kingdom marked "M" represents machinery and mill work, but not steam engines for which the curve "S" is drawn. In order to compare the curve of the British engine and machinery trade with the curves representing the trade of Germany and the United States, the curve "M + S" has been drawn, which combines the totals under each heading.

Far East.—As a separate trade zone, the demands of the Far East, which is reckoned as comprising China, Japan, Korea, and the Philippine Islands are exceedingly varied. Government stores go to Hong Kong, and Kiaochow. To these ports also go articles for sale in China. The Philippine Islands have, since the war, become an

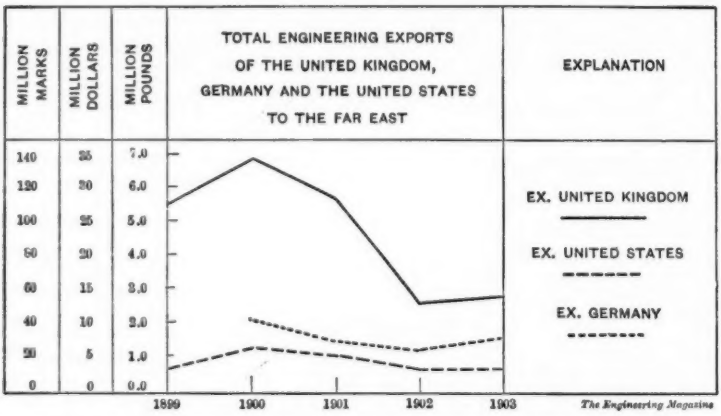


FIG. 5. TREND OF ENGINEERING EXPORTS TO THE FAR EAST.

important market for American goods, needed in the development of a backward country possessing great natural advantages. Above all, Japan has required nearly everything that the engineer can supply—from lathes to armour plates, from dynamos to looms, from ploughs to locomotives or battle-ships. The following are the figures of the total trade:—

EXPORTS TO ZONE 5.—FAR EAST.

Year. Ex	1899.	1900.	1901.	1902.	1903.
	In thousands of pounds sterling.				
United Kingdom	5,592	7,005	5,895	2,789	2,904
Germany	....	2,258	1,558	1,491	1,722
United States	832	1,458	1,225	742	850

Diagram No. 5 represents the above figures. In Diagram No. 6 are shown the exports of the three chief countries to the Philippine Islands; the manner in which the trade of all three countries increased in 1900 being remarkable. British manufacturers will note with in-

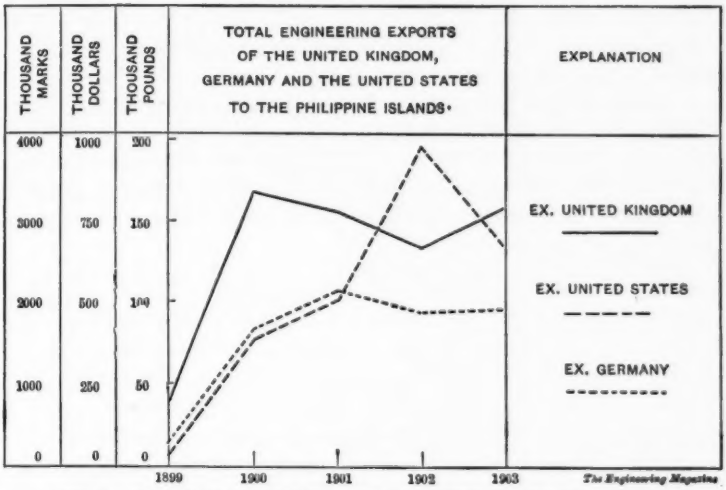


FIG. 6. EXPORTS OF THE THREE CHIEF COUNTRIES TO THE PHILIPPINES.

terest that in 1903 British exports were again in excess of those of either of the rival countries.

Diagram No. 7 shows an analysis of the engineering purchases of China as a whole. Hong Kong is a larger market and entrepot than is Kaiochow; the German predominance is due to goods sent to

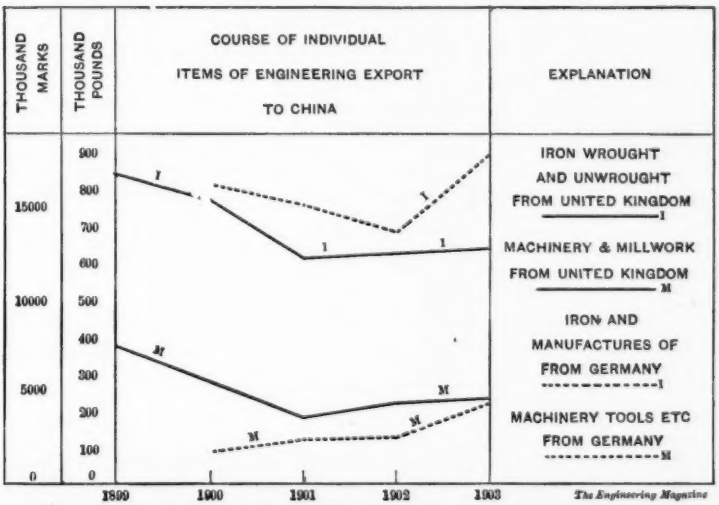


FIG. 7. AN ANALYSIS OF THE ENGINEERING PURCHASES OF CHINA.

the various treaty ports, rather than to goods sent to Kiaochow. The British position is not satisfactory to British engineering manufacturers, but the American position is still less so.

Japan, which is the chief purchasing country in this group, buys chiefly from the United Kingdom, the second place being held by Germany. Diagram No. 8 shows the export trade of the three countries under various items. In the case of the items of British export, ships and their machinery are not shown by a separate curve, but their value is given below:—

Year	1899.	1900.	1901.	1902.	1903.
Value	£3,413,112	£2,597,994	£3,366,799	£252,080	£55,817

It is due to the fall under this heading that the British total exports (shewn in Fig. 5) to this zone have receded so largely. Purchases of battleships are by no means a constant direction of expenditure, and Japan's purchases have widely fluctuated. Apart from this item the British trade has been fairly well maintained.

South America.—Of the neutral markets of the world, South America is notable in one respect—in that from north to south there

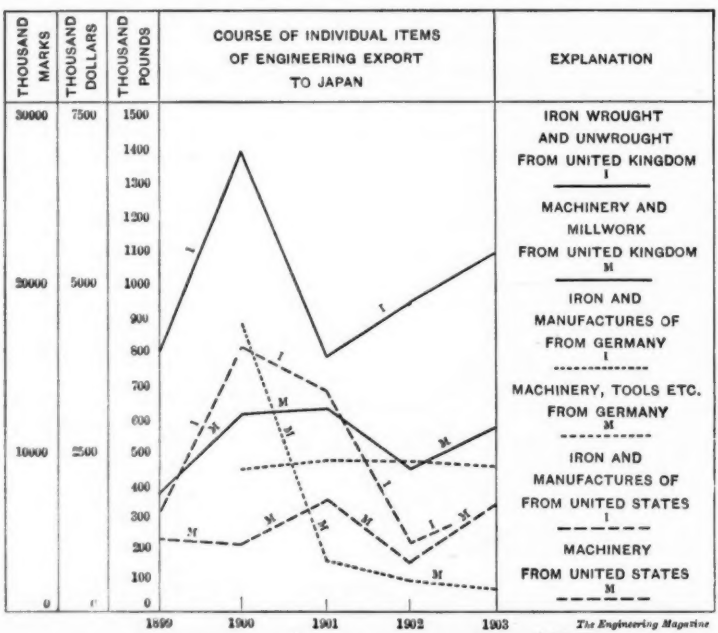


FIG. 8. EXPORT TRADE OF ENGLAND, GERMANY, AND AMERICA TO JAPAN.

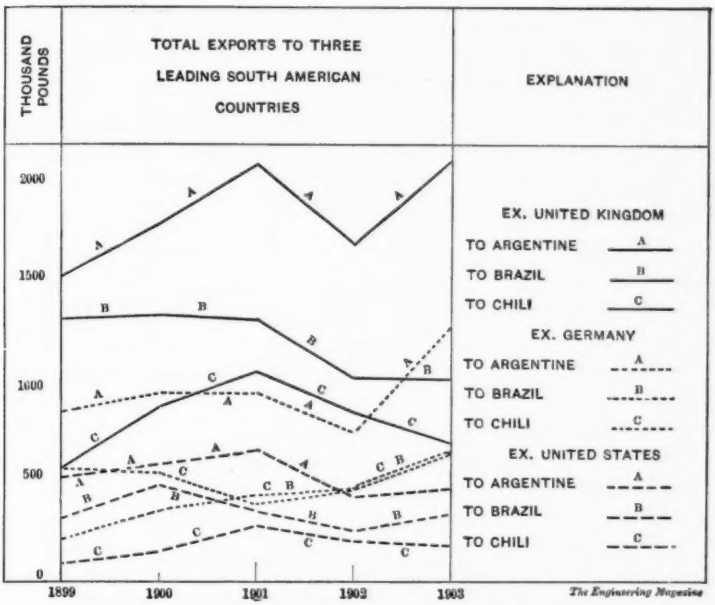


FIG. 12. EXPORTS TO LEADING SOUTH AMERICAN COUNTRIES.

is but one official language, and that the language not of either of the three chief manufacturing countries, but that of a country formerly a world power. The English, German, and American manufacturers in dealing with a Spanish-speaking people are pretty well on a level linguistically. Not absolutely, however, for the linguistic superiority of the Teuton is largely rendered valueless by reason of the large number of English-speaking engineers who "run" the South American Continent. The following figures show the manner in which the British trade takes the lead, the growth of the German trade, and the stagnant condition of the American trade:—

Year.	1899.	1900.	1901.	1902.	1903.
Ex	In thousands of pounds sterling.				
United Kingdom	3,823	4,539	4,589	4,164	4,396
Germany	1,819	2,234	2,255	2,112	2,978
United States	1,248	1,489	1,761	1,301	1,336

One reason may be put forward as partly explanatory of the inferior position of American trade in this region, and that lies in the fact that the products of the various South American countries are products of food stuffs and raw materials. With these the United States is well equipped, and Great Britain and Germany in competi-

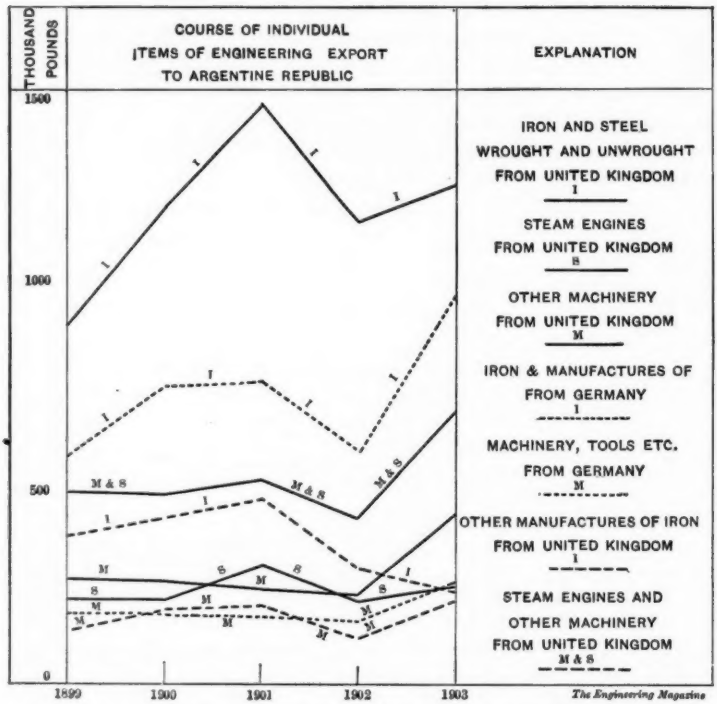


FIG. 13. ITEMIZED ANALYSIS OF EXPORTS TO THE ARGENTINE REPUBLIC.

tion barter manufactured articles for South American produce. Diagram No. 10 shows the respective exports to the Argentine Republic, Brazil, and Chile, which are the three chief purchasing countries in South America. To each of these countries the United Kingdom sends the greatest proportion, although as regards Chile the German trade now nearly equals the British. The similarity of fluctuation in regard to the trade of each country with the Argentine Republic is rather remarkable. The similarity is more apparent than real, because each year of the American returns ends (as pointed out in the last issue of THE ENGINEERING MAGAZINE) on June 30 instead of December 31. The Argentine Republic being the chief purchaser, it will be of interest to regard its imports as typical of South American demands, and consider the individual items from the three countries. As in the case of India, Egypt, and Japan, the British exports of iron (wrought and unwrought) head the curves. The German exports of iron (and manufacturers thereof) take second place.

THE RELATION OF PURCHASING TO PRODUCTION.

By William D. Ennis.

THE ENGINEERING MAGAZINE has been the source of much of the existent literature dealing with the organized study and management of two of the great elements in the economy of manufacturing—labor, and general expense. We believe it will be of interest to supplement these with a further study of the application of scientific business methods not only to the internal handling, but also to the supply, of the third prime factor in manufacturing—materials.—THE EDITORS.

ASSUMING that the works superintendent is responsible for the consumption of materials per unit of output, while the business manager is accountable for the cost thereof, there appears a necessity for a third element in industrial organization, having jurisdiction over the prices paid for materials. This is the function, as usually understood, of the buyer. He is technically differentiated from both superintendent and manager, bearing no formal responsibility regarding the consumption of materials, either absolute or in proportion to production; nor, usually, regarding the costs per unit of production, so long as the prices paid are low. This strict limitation of the accountability of the purchasing department is, and should be, never adhered to. Properly considered, buying has other relations intimately associating it with considerations of production-intensity and profit, the nature of these relations, and their utility, depending upon the kind of industry and its mode of organization.

For the present purpose, all productive industries may be comprehended under four general classes, in which the purchasing departments naturally develop in different directions, and with almost wholly different bearings on operation.

1.—The Trading Industry. This class comprises such kinds of manufacturing as are usually quite intimately associated with some phase of agriculture or mining—which utilize one principal raw material, the direct product of the earth, subjected to one simple general process; in which the amount of labor involved may be large or small, without affecting the general principle underlying such industries—that of a simple treatment of a single material. Transportation is often a large factor. Typical establishments in this class are linseed and cottonseed oil mills, ground wood-pulp mills, and flour mills. The purchasing of the raw material in such industries is the vital feature,

and as such is almost always taken charge of directly by the chief executive. Such other buying as is done, usually limited to a few items like packages, fuel, etc., is repetitional, and does not require exceptional skill; neither has it such fundamental relations with manufacturing costs as exist in other industries; nor does it involve the amount of detailed attention necessary in the purchasing department of a more complex manufacturing business.

2.—The Factory. Using the word in a narrowed sense, this term applies to that kind of business in which labor, directly employed, is the vital item—such as a textile mill, or the ordinary machine shop on small work. In these, purchasing efficiency is almost wholly subservient to conditions of productive intensity, the main point in buying being to err, if at all, on the side of extravagance, rather than take any chance of interrupting or complicating the routine of operation. In this, as in the preceding class of industries, the buying of any large elementary raw material is committed to the direct care of the management; other buying is apt to be an insignificant item, unless in connection with the repairs and maintenance of the plant, in which direction buying is of so highly specialized a character as not to permit of much comparative analysis.

3.—The Service Corporation. This includes such enterprises as power and water-supply plants and gas works. These, partaking in some respects of the distinguishing features of other classes, have the characteristic of a usually large construction and maintenance department, often (perhaps usually) superintended separately from the operation of plant. This superintendence itself consists largely in buying, under contract or otherwise, the buying being specialized to the highest degree and demanding usually not only commercial but technical experience as well.

4.—The Manufacturing Business. In the arbitrarily limited sense in which this description is here applied, it refers to that large class of plants in which the raw materials are many, the items of cost several in number and of commensurable magnitude, the prices of materials having a wide range, with proportionate effect on cost of production, and the labor item not an overwhelming one. Such a description comprises establishments like paper mills, some chemical industries, and the usual order of engineering works. In these, efficient buying is of prime importance, often fully as important as efficient superintendence of plant, in its effect on cost of production. Its relations with superintendence and management are close and constant, and its organization should be effected with a view to making such relations most mutually profitable.

It goes without saying that the lines separating the above four classes of industrial plants are too sharply drawn, and that the distinctions made are modified in many ways, involving corresponding modifications in the organization and conduct of the department of buying. The object of this classification being, however, to limit the discussion primarily to the scope of purchasing in the fourth class, or more purely manufacuring business, its utility will be recognized.

In the organization of a purchasing department, one complication often exists—that of a warehouse or stores department, to which all supplies are charged, and which in turn delivers them to the appropriate departments, charging to the proper account at the time of delivery. Justification for a warehouse department may be found under any of the following conditions:—

a. Where the same materials are used by more than one department.
b. Where a large or valuable stock of materials is left on hand, the invoices do not represent the rate of consumption, and accurate monthly inventory by departments is impracticable.
c. Where the cost of repairs is a large item and requires analysis; in which case, the warehouse department should deliver goods to the repair department only on requistion showing to what department and use the material is to be applied, thus recording the repair expense by departments.

In cases where the organization comprises such a warehouse department, copies of all purchasing requisitions or orders should be filed at the warehouse, these not necessarily being endorsed with prices. This department is then responsible for the receipt of materials in good order, their weight, quantity, and in a general way, their quality, thus relieving both purchasing and operating departments of some of the duties of inspection. The warehouse department can approve the invoice items "goods received," "quantity O. K.," and in some cases, "quality O. K." (Form 1.) The plant manager can of course determine in each case whether the warehouse department's approval of quality should be final. If it is preferred that the invoices should not pass through the warehouse, then that department should report daily, or oftener, on the receipt of goods, stating shipper, quantity and apparent quality (per brand or label, or as to condition). These reports constitute the basis for the purchasing department's approval of invoices; in addition to which it should secure the approval of the operating department as to quality, and may itself approve prices and discounts and pass bills for payment.

In order to avoid, or at least to fix responsibility for, delays, the items "goods received," "quantity O. K.," "quality O. K.," and "date approved," should always be endorsed with the dates of receipt, inspection, and approval, as well as with the initials of the approver. Form 1 shows the plan of endorsement recommended for invoices.

Pur. Order No. _____	Req. No. _____
Goods Rec'd _____	Account _____
Quantity O.K. _____	Quality O.K. _____
Price O.K. _____	Date Approved _____
Approved for Payment _____	Buyer
_____	Auditor
_____	Business Manager

FORM 1. RUBBER STAMP FOR INVOICE APPROVAL.

The "Requisition Number" refers, of course, to the requisition from the operative department, often elicited by suggestion. These requisitions are made out in duplicate, the copy being retained. In order to avoid delay in the payment of bills and consequent loss of discount, the above form should be stamped on every invoice as soon as received, which then becomes "live" and calls for attention until fully endorsed and passed. Sometimes the additional item, showing the date of receipt of the invoice, is desirable. This should always be embodied in the stamp when a time stamp is not used for all mail received. Other items may be desirable for convenience in accounting. In cases where materials arrive before the invoice, the daily warehouse reports consititute "live" matter, suggesting a prompt call on the shipper for the bill. The four approval signatures provided for on the above form are not in all cases required; but in general, all charges should have the approval of operating, purchasing, and auditing departments—where possible, the executive also.

The following page shows the recommended form for requisition on the purchasing department, which should be invariably adhered to, as showing the origin of every expenditure for supplies.

The number on this requisition should correspond with that on the stub, both being printed in. Where requisitions originate from several branches or departments, their numbers should have distinguishing letters prefixed. The blank space in the body of the

requisition is for temporary memoranda regarding prices, by the buyer. The space headed "Remarks" can be used by the formulator of the requisition to embody any recommendations or advice as to quality, source of supply, or prices. The item "for use at" shows the name of the branch or department. The various datings and other particulars given (with the usual time stamp showing the hours of receipt) specify the dates of requisition, of approval, of action by the buyer, and of purchase. The quotation numbers refer to the quotation file, hereafter to be referred to. The stub forms an acknowledgment showing the operating departments that the requisition has been received and attended to, and giving all necessary information as to probable delivery. Many of these entries may be by rubber stamp.

Even after a purchasing order has been issued and the requisition stub returned to the operating department, the requisition is still a

A. B. C. Co.

PURCHASE REQUISITION

NO. _____ DATE _____

To Purchasing Agent;

Please Furnish the following;

QUANTITY	DESCRIPTION OF MATERIALS	LEAVE THIS SPACE BLANK	REMARKS

For use in _____ Dept. Account _____

Delivery not later than _____ 190

(*Signed*) _____

Approved _____ Manager. Dated ____ 190_

Quo.Nos. _____ Pur.Order No. _____ Date ____ 190 _

STUB

To be returned to Operating Dept.

No. _____ Department _____ The attached bill of materials has been ordered from _____ for delivery _____ 190 _____

(*Signed*) _____ Buyer

FORM 2. PURCHASE REQUISITION.

"live" document, and remains so until the plant (or warehouse, if any,) reports the delivery of the goods. It may then be filed, the delivery report or invoice taking its place. It is at this point that the critical point of effective buying appears. The efficient buyer must deliver materials on time. It is for this reason that all requisitions must be held as "live documents," until there is proof of shipment and delivery. This point will be referred to later.

The receipt of a purchase requisition properly endorsed is the buyer's warrant for action. To save time, or for other reasons, it may frequently be necessary to get prices before the final approval of the requisition; perhaps in some cases the completed purchasing order will be attached to the requisition for joint approval. The first step after receiving the requisition is to decide whether or not a price-quotation should be secured before ordering. Standard goods, like pipe and fittings, bar iron in small lots, cement, etc., may vary in price so slowly that it is not necessary in all cases to call for prices. Where quotations are desired, time may be saved by using the following form, on which the buyer enters only the names of the parties from whom quotations are to be secured, and the number of the requisition. He will have previously made note on the requisition itself of any details or modifications in the specification of the material, so that a subordinate may copy the further particulars necessary into the quotation-request form. When quotations are secured by telephone, all the prices may be entered on a single card.

No. 1 First St., New York

NO._____ _____ 190__

M_____

_____

Please quote by earliest mail your price f. o. b.

_____ on the following;

_____

_____

_____

Yours truly,

A. B. C. Co.

Req. No._____ By _____

FORM 3. REQUEST FOR QUOTATIONS.

A. B. C. Co.

PURCHASE ORDER

NO._____ DATE_____190__

Invoices covering shipments on this order to be sent to
No. 1 First St., New York

M_____

_____

Please enter our order for the following

QUANTITY	MATERIAL	PRICE	
	F.O.B.		

Ship to_____ via_____

To be delivered at point stated on_____190__

(*Signed*) A. B. C. Co._____

Req. No._____ Per_____ Buyer

Special Note;-

Send B/L or Shipping Receipt covering shipment on this order to No. 1 First St., New York, immediately upon shipment.
Do not hold papers for invoice.
Failure to comply will cause us inconvenience.

NO._____ *ACKNOWLEDGEMENT STUB* _____190__

A. B. C. Co.
No. 1 First St., New York,

We are in receipt of your order numbered as above, which we accept, understanding the specified date and terms of delivery to constitute a condition of the order.

(*Signed*)_____

Please return this acknowledgement without delay.

FORM 4. PURCHASING ORDER AND STUB.

This blank is endorsed in duplicate, the copy being on a stiff card, suitable for filing, on the blank margin of which the price quoted is afterward entered. These quotation cards are filed according to the consecutive printed numbers in the upper left-hand corner, and an index register is posted daily. The last quotation number indexed shows the most recent quotation for that particular material. Red tabs may be employed on the cards, and check marks on the quotation index, to designate low prices. The entry of quotation numbers on the purchase requisition (Form 2) shows the number of quotations obtained. As quotations are received, they should be temporarily attached to the requisition, not being filed until the purchasing order has been issued. The latter may be as shown on page 525.

Having now placed the order, a book copy being retained, the next duty of the buyer is to see that the acknowledgment stub arrives by the earliest possible mail. This he attaches to the purchase requisition. It is then his concern to see that the goods arrive at their destination at the proper time. As already stated, he holds on file all original purchase requisitions. These are arranged, not in numerical sequence, but in the order of the specified date of shipment; and it should be the rule to examine and act on these daily. When the specified day of shipment approaches, the following printed note or post-card is despatched. The number, of course, corresponds with the purchasing-order number.

A. B. C. Co.

NO. _____ No. 1 First St., New York _____ 190__

M_____

_____

You have our order, numbered as above, dated _____ 190__, for _____, shipment on which is to be made _____ 190____

Please do fail to make shipment as specified.

(*Signed*) A. B. C.Co. per_____

FORM 5. SHIPPERS' REMINDER.

Possibly two or even more of these reminders may be required before a response is elicited; in which case each succeeding one should have some expression of urgency stamped across its face. It is not the business of the buyer to determine *how* urgently goods are needed; he should see that all goods are delivered on time. If there

is incompetence in the formulating of requisitions, delay in filling them is not the remedy.

Should the specified day of shipment pass without receiving papers showing that the goods have been shipped, special and prompt action should be taken, the steps being usually in the following order:—

a. Ascertain when shipment can be made.
b. Ascertain how much delay in arrival of the goods can be tolerated.
c. Cancel the order if necessary, and buy elsewhere.

At this stage (and, as a general rule, at this stage only) free use should be made of the telegraph and telephone. The function of the buyer should be active and not passive, in this as in the still more important phase of testing and inspecting materials purchased, and the somewhat elaborate system above described is certainly far better in every way than a haphazard method of taking things for granted, and waiting for a protest from the plant before being concerned with any thought as to the possible non-arrival of goods.

Any extension of time for the delivery of materials or a purchase requisition acts as a stay on the "life" of the requisition. Its vitality does not cease until the arrival of the shipping papers or warehouse receipt, either of which may take its place until the arrival of the invoice, which becomes the final document in the transaction, and is itself "dead" to the purchasing department so soon as it is fully endorsed and passed for payment.

An inexpensive and probably profitable courtesy in connection with this system is the use of one more typewritten or printed form thanking correspondents for quotations received in reply to Form 3, and stating if possible the reason why the purchase is not made from such correspondent. It will probably be found most effective to have such cards mailed quite promptly after the receipt of quotations, and two or three days before the order is placed.

A separate requisition from the operating department should be insisted on for each item or class of items. Where orders are sometimes placed by telephone, a stamp should be used showing the confirming order to be such and cautioning against repetition. A special blank form on which the operating departments may call on the purchasing department for prices may be useful, where the cost of some projected improvement or change in operation must be calculated.

Sometimes a considerable amount of correspondence is necessary before a quotation is obtained or an order placed. In this case (as in all other slips of the system) there should be practised rigorous "follow-up" methods.; the purchase requisitions (until the order is

placed) being filed in order of the dates when next action is due, or a calendar register kept, listing for each day the number of purchase requisitions calling for action.

Among indispensable aids to efficient buying, the complete quotation file, previously referred to, should have first attention. Supplementary to this, there should be intelligently designed records showing the variations in prices of the principal supplies purchased, accompanied by thorough analyses showing the reasons for the variations. Any opportunity for comparison of prices with those paid for the same materials by others should be taken advantage of, and the facts recorded. To be most fully familiar with the markets, the buyer should be supplied not only with his own trade papers, catalogues, and other publications, but also with the trade papers covering the markets he most often enters. These can usually be had gratis. Thus, if he is a large buyer of barrels, he should have the cooperage papers; if of building materials, the corresponding trade publications; etc. A card index may be maintained (sometimes combined with the quotation file, sometimes separately) showing the available sources of supply of the usual materials purchased. This can be supplemented by cards or an indexed scrap-book referring to information of all kinds obtained regarding prices and market conditions. At the earliest date which the development of the system will permit, a thorough analysis of expenditure should be made, showing the amount purchased of each kind and class of materials; the best season for buying each; the usual amount of stock on hand, and the permissible size of order. This information may often be of value in eliciting a requisition by suggestion when the time is opportune. In this as in other directions the usefulness of the buyer should assume an active form. Where the organization is large, so that the personal attention of the buyer cannot be given to the details of all purchases, the materials should be grouped in general classes and each class handled by one subordinate. Special knowledge is just as essential in purchasing as in manufacturing. Opportunities for visiting plants and learning factory conditions and methods as applied to the principal raw materials purchased, should be constantly sought. Familiarity with the uses of materials in the business should be obtained.

The prices at which goods are secured do not adequately represent the work of the buyer. The effect on production and cost of production must be more fully considered. With equal operative efficiency, effective buying is fully shown by the cost of materials per unit of output. A low price coupled with high consumption per

unit of production calls for investigation. It is too often the case that the buyer seeks the goods of lowest price, the plant operator being compelled to accept whatever is furnished. This lack of co-operation should be eliminated. The first essential is to have frequent, perhaps periodical, reports on the quality and appropriateness of all goods supplied, as determined by observation under service. Next is a system of promptly reporting on defects, showing the reasons for such defects and furnishing samples of defective goods. A more satisfactory and scientific system involves also the purchasing of materials on carefully drawn specifications, compliance with which is to be determined by laboratory tests. All usual materials may be bought in this way—paints, oils, brick, cement, iron, building materials generally, pipe, fittings, and pipe covering can be judged as to quality and suitability often with far more accuracy and promptness by laboratory tests than by actual service. In the mill, conditions are variable and the personal equation has too large an effect. In comparing different kinds of belting, for instance, it is almost impossible to formulate fair conditions for a service test, or even such as will constitute a safe guide in buying. Moreover, a service test requires considerable time, often several months, during which a possible saving may be delayed; and a delayed saving is always a loss. A bureau of tests, working in close co-operation with purchasing and operating departments, and held responsible in cases of complaint as to quality of goods under service conditions, this bureau furnishing specifications to the buyer and reporting as to compliance therewith, should be an adjunct to the purchasing work in most large industries. Where, after buying has been conducted along these lines, there is any complaint from the operating department, the testing department should investigate. Varying service conditions may have an influence on durability and consumption which must be recognized in the drawing up of specifications and schemes for laboratory tests; but all complaints should receive searching investigation, and the "why" be made known, prior to such modification. Sometimes it is an improper operating condition which needs correction, rather than a defect in materials.

In a purchasing department, whether large or small, simply or complexly organized, many documents must necessarily pass through several hands; and methods of avoiding loss, locating papers, etc., in vogue in other industrial systems, such as taking receipts by documentary numbers from each individual or department receiving them, should be adapted to the particular requirements.

In certain industries of exceptional magnitude, natural modifica-

tions in the methods and organization of the buying department occur; notably, for instance, in purchasing for railway companies. In the recent "integrated" mode of organization of many industries, involving the combination under one direction of a number of geographically separated plants, it has seemed wise to form a new basis for buying, consisting in the establishment of a central purchasing department, which takes direct charge of the buying of the larger and repetitional items, supervising at the same time the local purchasing of smaller items at the various plants. In most respects such organization does not differ in proper object and methods from the buying department of an isolated plant. It is usually the case that purchases made by the branches will be paid for at the branches, the vouchers afterward being sent periodically (best weekly, rather than monthly) to the general office, where they should pass through the hands of the purchasing department for approval. More direct control is secured by having the purchasing orders issued by the branches always made in triplicate, so that in addition to the copy retained at the branch office, another copy, completely endorsed as to price, may go immediately to the general purchasing department. If action should be necessary, it may then be taken at this stage, when it is often not too late to discuss or even to cancel an order. When vouchers come in, they should be checked against these purchase-order copies before going to the auditing department.

Where all bills are paid from the general office, the invoices are checked against the branch-office purchasing-order copies and warehouse receipts, and usually need not be sent to the branch for approval. This is the best form of control, but is seldom fully practicable on account of the delay involved in payment where the plants are widely separated from the general office. Where purchases have been made by the central office, the branch manager's approval of warehouse reports, forwarded by him to the buying department, enables that department to complete the endorsements on the invoice and pass it for payment. When the purchase requisition, Form 2, is used in local purchasing, some of the items may be eliminated without loss. In using Form 4 for branch-office purchases, the address should be that of the branch, unless all invoices are handled by the central office.

One of the principal advantages in purchasing-department organization, in an "integrated" industry, is the opportunity given for the comparison of prices paid on purchases of the same material by different branches. These should be constantly set side by side and variations justified or corrected.

PROGRESS IN VALVES FOR AIR AND GAS COMPRESSORS.

By Leicester Allen.

IN reply to the query "why do not the builders of steam-driven blowing engines, instead of using air cylinders of seven-feet diameter and five-feet stroke, use cylinders of less diameter, and for a speed of, say, forty-two revolutions per minute substitute a speed of one hundred revolutions per minute?" I received from one of the most accomplished and competent engineers in the United States the following statement, which I give verbatim:

"It has been found almost impossible to get an air valve-gear which would work satisfactorily at speeds much above fifty revolutions per minute on low-pressure work where the air cylinders are very large, and where the valve area, particularly that of the inlet, must be a very large percentage of the piston area in order to prevent a suction loss in filling the cylinder."

Again, in conversation with another able engineer, the superintendent of a well-known compressor works, regarding the possibility of improving the piston packing of air compressors, I was met by the statement that, while pistons could doubtless be improved, the need for improvement in valves was more pronounced, and that, as yet, for all kinds and sizes of compressors, and for all uses, no all-around satisfactory valve has been produced.

The poppet valve is the type most used during a period of thirty years. At one time it was flat-seated. Then the conical seat prevailed. Now some manufacturers are going back to the flat seat. For some purposes a single slide valve for suction and discharge in a double-acting compressor has answered well, even with a maximum unbalanced pressure of 150 pounds per square inch between suction and discharge. A slide valve for the suction with a poppet valve for discharge is also used for some compressors. Mechanically operated inlet valves of the Corliss type for the suction, and poppet valves for discharge, are now quite extensively used. These changes have followed each other in the quest for the ideal compressor valve which, when it arrives, will meet the requirements for all compressors, of

whatever size they may be or whatever may be their application in the industrial arts; and, as change always argues dissatisfaction, it seems that I am backed by authority of first-rate engineers, as well as the facts in the history of air compression, when I assert that a perfectly satisfactory type of valve for air compressors does not exist.

The term, "air compressor" applies in its broadest sense as perfectly to what is more generally termed a vacuum pump as it does to a compound compressor which, inducting air at a pressure of one atmosphere, effects a pressure of twenty-eight atmospheres; in fact, the ratio of compression in a pump producing a vacuum as low as one inch of mercury is about 30, or as great as in compressing air at 62° F. from one to 29.92 atmospheres. But while for a small laboratory vacuum pump a valve of oiled silk will answer well for the suction, the poppet valve of the large blowing engine with suction pressure of one atmosphere requires a ponderous casting. If two suction valves are used for these large air cylinders, even with a mean velocity of flow through the valve openings of 8,000 feet per minute, it can be readily computed that the combined suction area for the air cylinder of a blowing engine 7 feet in diameter and 5 feet stroke must be 3.88 square feet; the diameter of each valve, if opened to full area, would be 18⅞ inches, nearly. Its lift to give full area would be a little more than 4¾ inches. It is easily conceived that such a valve, cast integrally with guides and strengthening ribs, must have a weight which, for practical reasons, precludes its actuation by a spring, and seating with a blow; hence they are actuated mechanically by rock-levers. But, at the best, quick seating of such a valve is impracticable and the speed of the engine is thus limited. It is true, however, that in blowing engines where gas instead of steam is used, a speed of 90 revolutions has been reached by the use of mechanically actuated valves. Few mechanical engineers, not directly engaged in the manufacture of air compressors, have considered the wide range of conditions here outlined as existing between the small vacuum pump and the ponderous blowing engine; and, in view of all the requirements, it may be doubted whether a valve meeting them all satisfactorily will ever be forthcoming.

But though vacuum pumps are, strictly speaking, compressors in the most general sense of the word, they are not commonly so called; and they have a peculiarity in their action which practically puts them—and all compressors which, after compressing to a stated pressure, cease working—in a class by themselves. This peculiarity is that their ratio of compression, when the space to be exhausted contains air at atmospheric pressure, is zero at beginning, and con-

stantly increases to the end of the operation. It is true that compressors taking air at atmospheric pressure and forcing it into a receiver until the latter is filled with air at a prescribed pressure, start with a zero compression ratio which increases till the stated pressure in the receiver is attained; but at this period the compressed air is taken from the receiver as fast as it is forced in, for driving air motors or for other useful purposes. If this be done uniformly, the ratio of compression thereafter remains constant. If the air be drawn from the receiver in irregular quantity, there will be greater or less approach to uniformity in the ratio of compression. It will increase or decrease according to the demand for the compressed air, but will not constantly increase as is the case with the vacuum pump. It is, doubtless, this variation in pressure ratio, more than any other cause, which has influenced the use of poppet valves for the discharge of air compressors, aside from their automatic action which requires no special mechanism to control their movement except a spring to insure their prompt closing. It is, doubtless, also the fact that, because this variation of pressure ratio does not exist in connection with the filling of the compressor, or the suction, the use of positively actuated suction valves, in place of poppet valves, has been evolved in modern practice.

In cold-air refrigerating machines which use compressed air, delivered by a compressor, in an air engine wherein the air is expanded for the production of cold and the work of the expansion assists a steam engine to drive the machine, as soon as the machine arrives at the point of normal working, the pressure ratio becomes constant. The ordinary slide valve with a cut-off slide on the back works satisfactorily on these machines, and has been in use for years without creating a desire for anything better. There is no question that such a valve can be practically applied to any compressor which works under a constant pressure ratio. Of course, with this kind of valve the suction is effected through what is the exhaust port, and the compressed air is discharged through what are the induction ports in a steam engine, the course of the air during its passage being exactly the reverse of that of steam. The slide on the back of the main valve uncovers the valve port at the point of the piston stroke whereat the pressure of discharge is reached, instead of covering the valve ports at the point of cut-off, as in the steam engine. These valves work noiselessly, and as only one is required for a double-acting compressor, while, at the least, four poppet valves are required, and as they are far more durable and less liable to derangement in their action than poppet valves, their advantages for all pumps working

under constant pressure ratio, if no counter disadvantage existed, would seem obvious.

Unfortunately, a disadvantage does exist, which, in the case of vacuum pumps designed to effect a very good vacuum, is absolutely fatal, and which seems to be insurmountable. Such a valve cannot be applied to a double-acting pump without an amount of clearance between the face of the valve and the piston which prevents a sufficiently complete discharge of the compressed air. There arrives a time when the air filling this clearance compressed to atmospheric pressure, is enough, when it expands to the lower suction pressure, to completely fill the cylinder together with the clearance space, and suction ceases when this occurs. When this condition is established the limit of the vacuum is reached. But for compressors compressing air from a pressure of one atmosphere to a higher pressure, into a receiver from whence the contained air issues at a uniform rate (as is the case with the blowing engine) I can see no valid objection to this type of valve. In this and analagous cases the air is compressed to a stated pressure, and hence the ratio of compression is practically constant; therefore the point at which the slide on the back of the compressor main valve should uncover the discharge port can be determined with exactness, and the valve gear set to positively attain such opening. In the case of air compression for supplying motors and lifts in a shop, an approximation to a uniform stated pressure can be gained by using a receiver of so large a capacity that a sudden demand for air supply will not materially lower the pressure before automatic regulation is effected.

The compound system of compression, besides other practical advantages, lessens the ill effects of clearance or waste spaces in the compressors by lessening the ratio of compression in each of the compressors used in the system. For this reason much better results are attained in vacuum pumps by compounding than are possible with a single-cylinder pump. But the fact is that only slight decrease of economical efficiency is caused by a moderate clearance in incondensable gas compression from atmospheric pressure to a higher pressure, and that, in pumps for such work, clearance is not the important defect it was once considered to be. A slight increase in the stroke or the diameter of the compressor cylinder, or of both diameter and stroke, will compensate for the diminution of capacity due to expansion of air remaining in the waste spaces after the discharge has ceased, and as this residual air gives back to the piston on the suction side nearly all the power required to compress it, an almost negligible loss of power is sustained.

Probably the poppet suction valve used in some of the single-acting vertical compressors works as satisfactorily as any valve that ever has been, or will be, devised for the purpose. This valve, when working, requires no spring for its closure, neither is gravity concerned in its action. It opens and closes by its *vis inertia* alone. It is, as well-known, placed in the piston instead of in the cylinder head or bonnet, and it is nicely balanced or poised on a coiled spring that supports its entire weight, allowing it, when at rest, to close down almost tight upon a conical seat to which it is nicely fitted by grinding. Now, if we could suppose a perfect vacuum to exist in the cylinder and the piston to have a velocity a little greater than that which the force of gravity would produce from rest in the time required for its movement, the valve would open and remain open during the downward stroke, and close and remain closed during the upward stroke. In actual work the space above the piston fills during the downward stroke, the gas being then transferred from the lower to the upper side of the piston. During this stroke inertia causes the valve to lag behind its seat, and, consequently, to remain open independently of the pneumatic pressure. When the piston reverses its motion at the end of the downward stroke, the valve does not reverse its motion till it meets and closes upon its seat, this action taking place during about four degrees of crankpin revolution over the dead center, and hence being well-nigh instantaneous. These single-acting compressors, allowing the use of the well-known safety-head, practically eliminate waste spaces on the compression side of the piston. I believe that, with the single-acting compressor having a perfectly acting piston and tight valves, as fine a vacuum can be produced as can be attained with any apparatus except the mercury air pump. The suction-valve seats accurately without noise, and is easily kept tight; but it can be used in single-acting compressors only, and while with such compressors poppet suction valves give less trouble than on the double-acting, the cylinders must be of nearly twice the diameter with equal stroke to reach the same capacity.

With regard to construction, we have two leading types of compressors,—the single-acting and the double-acting reciprocating compressors—with, possibly, the promise of a third type—turbine compressors, which may be exploited sooner than expected. They are certainly within the range of mechanical possibility, reasoning from the success that has been reached with steam turbines. They will not be concerned with the compressor-valve question.

With regard to their action, we have three classes: compressors which work with a constant pressure ratio, those which work with

a constantly increasing pressure ratio, and those which work with alternately increasing and diminishing pressure ratio.

The suction valves of all these compressors may be positively actuated by mechanism, and the discharge valves of the first and third classes may be positively actuated, provided the variable pressure ratio of the third class be reduced as much as possible by means already discussed. Both the first and third classes of compressors may be successfully operated by a single main slide-valve, with a cut-off slide if the pressure ratio varies little in the third class. The second class of compressors must have automatically acting discharge valves to avoid an excessive waste of motive power. The simplest form of automatic valve yet devised for air-compressor work is a poppet valve; but it has many defects. To afford full opening it requires too great lift, and if to avoid this defect a multiplicity of valves be used, defective closing cannot be positively attributed to any one of the valves without an examination of the entire set. Except in the case of the suction valve in the piston of the single-acting compressor, poppet valves are always more or less noisy and wear rapidly under continuous work. Obstructions, such as scale jarred from the interior of pipes, are liable to be trapped between their faces and their seats, and frequently injure the ground surfaces, necessitating regrinding. The springs, unless very carefully made and tempered, are apt to break, in which case a fragment of the broken spring may cause injury. In short, although the poppet valve may be the best automatic valve yet available, many an engineer has longed for something which would save the care required to insure its efficient operation.

The ideal valve is one that never leaves its seat. Of valves which in action remain constantly seated, we have the types of the common locomotive slide, the rotary, the piston valve, the oscillating rotary (of which the Corliss valve is the prime favorite) and a large variety of gears for positively actuating each of these types. The grid variety of slide valves and the piston valve can be made to give a large valve opening with less motion than others, and large suction-valve opening is essential to progress if smaller compressors with higher piston speeds are ever to take the place of the present machines. Proceeding from these types, there may yet be evolved valves reasonably satisfactory in meeting the requirements of each of the three classes of compressors; but the difference in these requirements seems to preclude the hope that any one kind of valve will answer for the entire category. But in our age of rapid progress who will venture to assume the *rôle* of a prophet?

THE EFFECTS OF VACUUM ON STEAM-ENGINE ECONOMY.

By R. M. Neilson.

With this article Mr. Neilson concludes his discussion of some of the most important factors in steam-engine economy. The review began in our issue for March last, and after devoting two papers to the subject of superheated steam, followed in May and June with a consideration of the economy of condensing, and the principal types of condensers and their operation. The concluding section, now presented, completes the discussion of condensing systems and the auxiliary machinery of the condensing plant.—THE EDITORS.

IF the water supply is scarce, condensing is in many cases only possible by using much less water than is usually required for surface, jet, or ejector condensers. Even if the water supply is plentiful, it may be (and is in many cases) so expensive that no financial gain can be got from condensing unless the consumption is restricted by employing some form of evaporative condenser or some re-cooling device for the condensing water.

We can greatly reduce the consumption of condensing water by using the same water over and over again, supplying continually or intermittently a little fresh water to make up for losses by leakage and evaporation. This means that we must have cooling tanks or cooling towers or the like for the water. Cooling towers are arranged to expose a large surface of water, and are as a rule to be preferred to tanks or ponds, as they take up much less ground area and as a rule cost less to begin with, although the upkeep of a tower may be greater than that of a well constructed tank or pond. Sometimes the tower is closed in and air is mechanically propelled against or over the water in the tower so as to increase the rate of cooling of the water. This allows a much smaller tower to be employed, or the water to be cooled to a lower temperature with the same size of tower. Where the available ground area for a tower is restricted or where it is desired to obtain condensing water at a temperature approaching that of the atmosphere, this mechanical ventilation may be very useful. As a rule, however, it pays better to dispense with it, as the fan, to make much impression, will absorb as much power as the air and circulating pumps put together. Sometimes the tower is closed in but no fans employed, a chimney being arranged over the tower so as to produce a natural draught. This arrangement

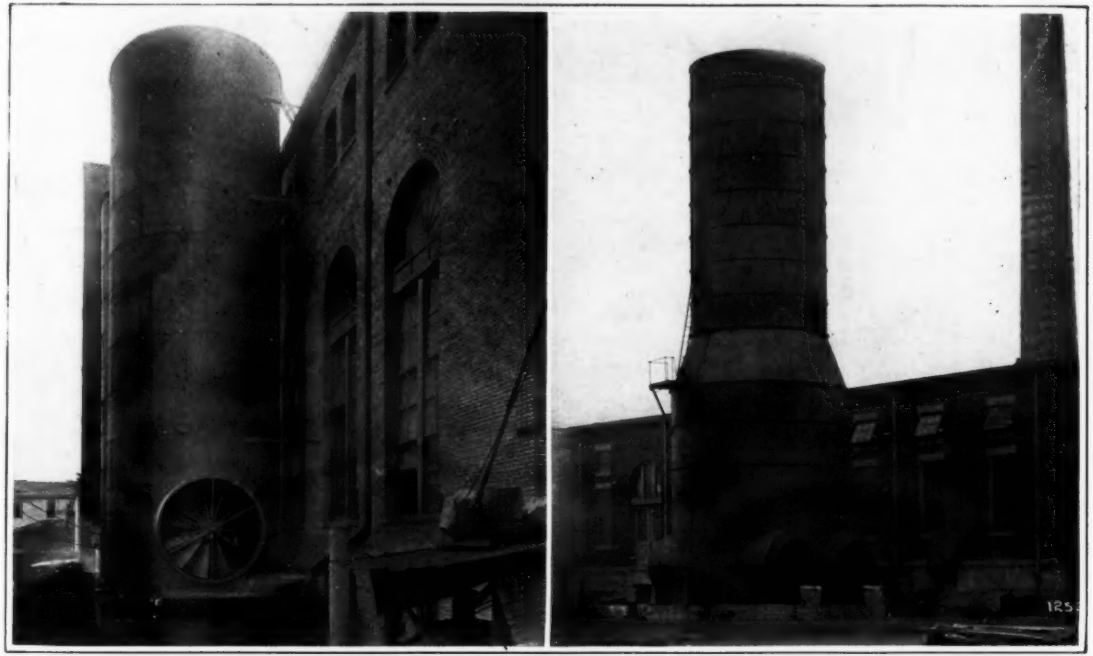


FIG. I. TYPES OF FAN-COOLED COOLING TOWERS.

On the left, a group of five cooling towers for the Georgia Railway & Electric Co., Atlanta, Ga.; hourly capacity, 55,000 gal. each; built by George J. Stocker, St. Louis, Mo.; on the right, a combination natural and forced-draught tower at the Worthington Hydraulic Works, Harrison, N. J.; 26-ft. diameter base, 85-ft. high; four 108-in. fans; normal rating, 65,000 lb. steam per hour. A water seal, determined by the level of the overflow, closes the bottom when forced draught is to be used. International Steam Pump Co.

may be considered intermediate between the fan-cooled tower and the open tower and occupies floor space intermediate between the two. The floor space of course varies according to the nature of the tower, the temperature at which the water is received and discharged, and the temperature of the atmosphere. Generally speaking, these towers require a floor space of ½ square foot to 2 square feet per horse power of engines served. A fan-cooled tower absorbing about 2 to 4 per cent. of the power of the engines served, occupies with its fans and motors (roughly speaking) about one-third of the area required by an open tower.

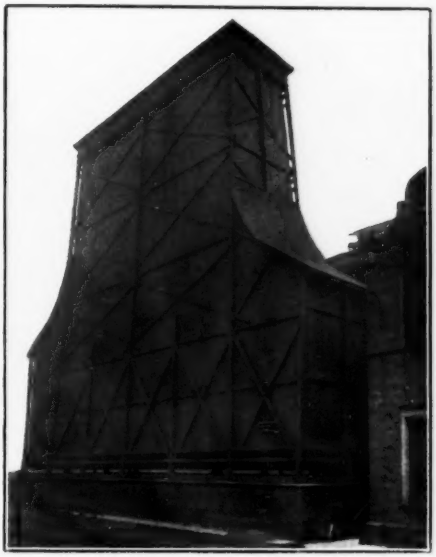


FIG. 2. NATURAL-DRAUGHT COOLING TOWER.
Klein Engineering Co., Ltd.

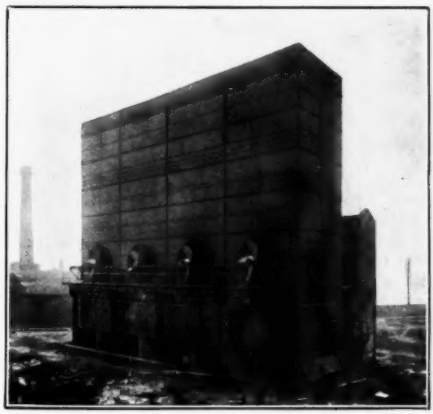


FIG. 3. FAN-COOLED TOWER ERECTED ON TOP OF TANK.
Klein Engineering Co.

Figure 2 shows a natural-draught cooling tower constructed by the Klein Engineering Company, Ltd., of Manchester, for use at an electricity works. The lower part of the structure is filled with wooden frames. The water to be cooled is raised to a height of about 25 feet and delivered into a main trough situated at the top of the frames,

From this main trough the water flows by way of distributing troughs into a series of small gutters which discharge it so that it flows down the frames. The water is exposed in thin films to the cooling action of the air and loses heat partly to the air and partly by evaporation. The tower is closed in by a wooden casing, braced as shown.

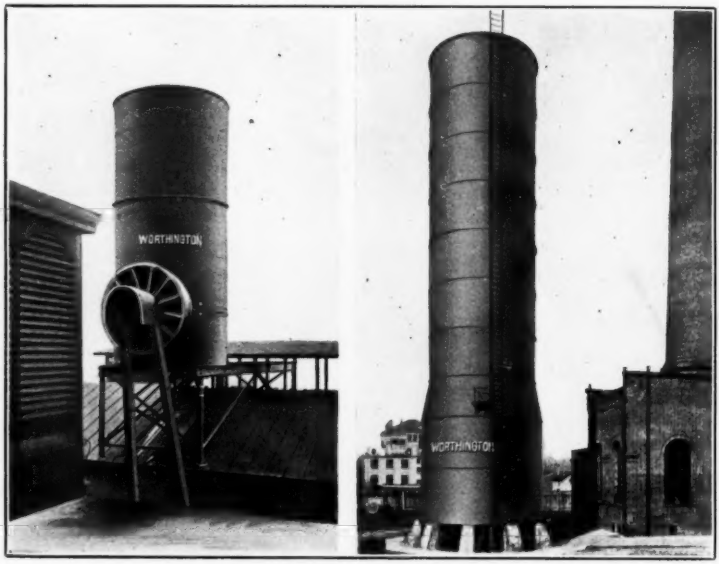
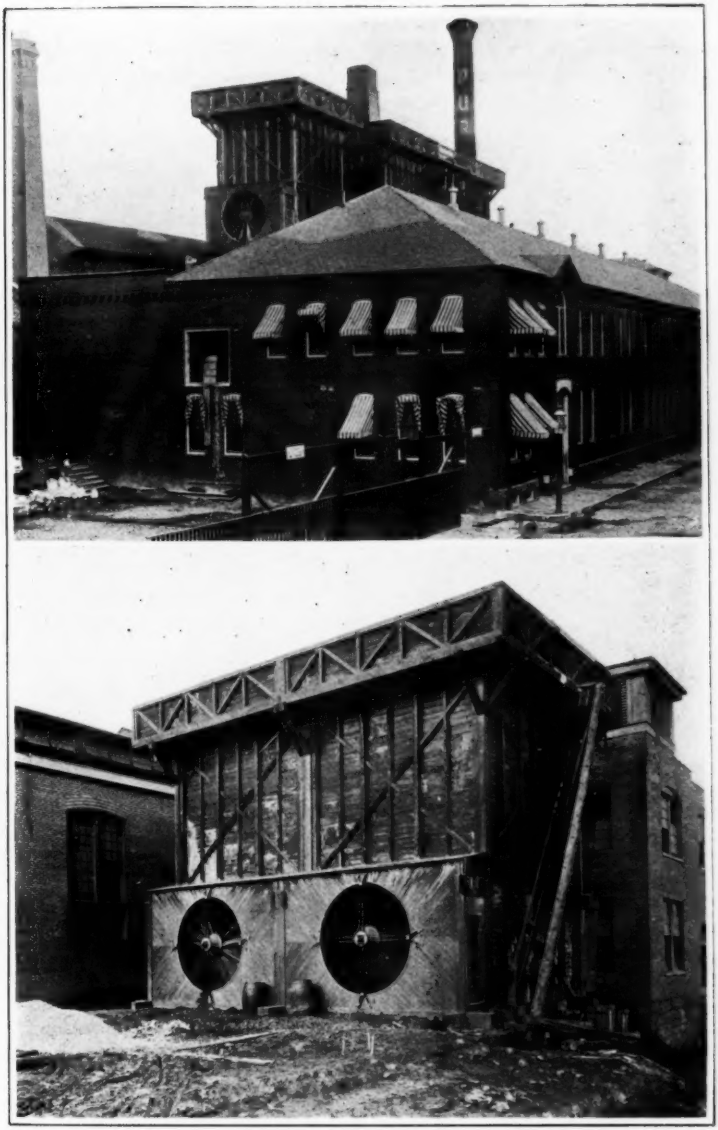


FIG. 4. EXAMPLES OF COOLING-TOWER INSTALLATIONS.
That on the right is fan-cooled; that on the left—at a German power plant—is cooled by natural draught. International Steam Pump Co.

Figure 3 illustrates a Klein fan-cooled tower. Eight fans are employed—four at each side of the tower. By these fans air is forced into the tower, a guiding plate being arranged in the centre of the tower to direct the currents of air from the two sides upwards. The fans are driven by electric motors. This particular cooling tower, to suit local requirements, was erected as shown on a steel-girder framework at a height of about 20 feet above the ground, and with a cast-iron tank to collect the cooled water. This causes it to look considerably higher than it otherwise would. The capacity of this tower is 400,000 gallons of water per hour.

Another means of reducing the consumption of condensing water is to employ an evaporative condenser. In this the condensing water,



EXAMPLES OF COOLING-TOWER INSTALLATIONS.

Above, a group of three towers of 720,000 gal. capacity each, erected on roof of Commonwealth Hygienic Ice Co., Boston, Mass., by George J. Stocker, St. Louis, Mo. Below, a double tower of 1,600,000 gal. per day capacity, built by the same maker for the Polar Wave Ice & Fuel Co., St. Louis.

while condensing the steam, has a large surface exposed to the atmosphere and its cooling effect is increased by its withdrawing heat from the steam (to be condensed) to evaporate part of itself. Evaporative condensers can be run on one pound of condensing water per pound of steam condensed, giving a vacuum of 22 inches to 24 inches of mercury. They are often run on less water than this. No more water need therefore be used for running an engine condensing with an evaporative condenser than in running the engine non-condensing.

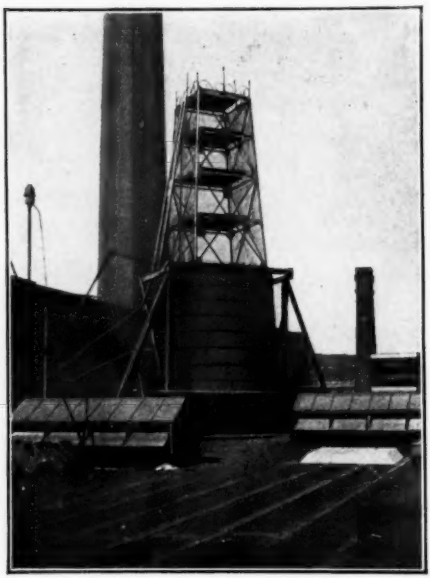


FIG. 5. ACME COOLING TOWER, REFRIGERATING PLANT OF SHEFFIELD FARMS-SLAWSON-DECKER CO., NEW YORK.

Capacity—100 gallons a minute. Built by B. Franklin Hart, Jr., & Co., N. Y.

Figure 6 shows an evaporative condenser supplied by Messrs. Ledward & Beckett, Ltd., of London, to the Midland Iron Co., Ltd., of Rotherham. This condenser is designed to be able to deal with 20,000 pounds of exhaust steam per hour. The steam to be condensed is led to the top of the condenser and zig-zags downwards through the horizontal pipes. Condensing water is led to the top of the apparatus and trickles down the outside of these pipes. The pipes are fitted with annular ribs which serve to increase very largely the cooling surface. The pipes are bolted together with flanged faced joints.

In order to obtain a good vacuum for steam turbines with a moderate sized condenser and air pump, the Hon. C. A. Parsons has invented a vacuum augmentor. This consists of a steam jet situated in the duct which leads the air and vapor from the condenser to the air pump, and which jet by an injector action helps to draw the air and vapor from the condenser and maintains a lower pressure in the condenser than at the inlet to the air pump. Figure 8 shows a con-

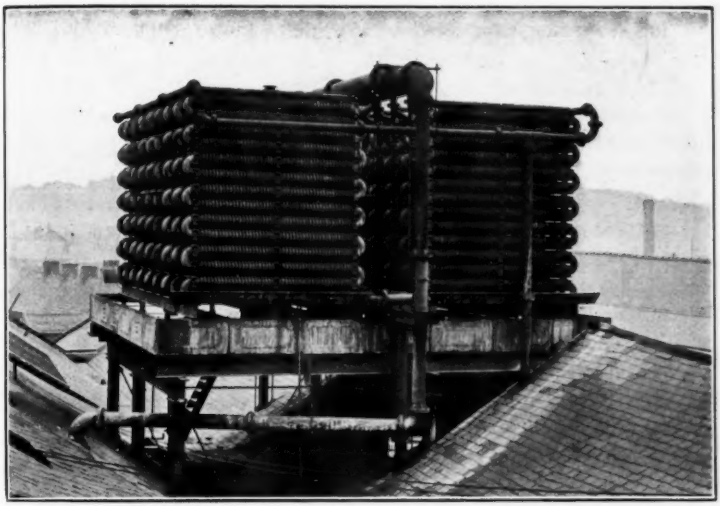


FIG. 6. LEDWARD EVAPORATIVE CONDENSER ERECTED AT THE WORKS OF THE MIDLAND IRON CO., LTD., ROTHERHAM.
Capacity—20,000 lb. of steam per hour.

densing plant arranged with this vacuum augmentor. The inlet to the air pump is situated about 3 feet below the bottom of the condenser. The air and water leave the condenser separately, and the air on its way to the air pump passes through an auxiliary condenser which has about one-twentieth of the cooling surface of the main condenser. The steam jet is placed, as can be seen in the figure, between the main auxiliary condensers. This vacuum augmentor with a steam consumption of one per cent. of that of the turbine may increase the vacuum into which the engine discharges from 26 to 27½ or 28 inches, the air pump acting however as if the vacuum was only 26 inches. Figure 9 shows the effect of the augmentor on the steam consumption of a 1,500-kilowatt Parsons turbine. It should be particularly noted that the cooling water used was at the somewhat high temperature of 85 degrees F. The consumption of cooling water was thirty times that of the exhaust steam at full load. The steam used by the jet amounted at the tests to 450 pounds per hour and this has been added to the steam consumed by the turbine in drawing the curves which represent steam consumption with the augmentor in use in Figure 9.* The consumption of steam by the jet has since been considerably reduced.

* Paper read by the Hon. C. A. Parsons and Messrs. G. G. Stoney and C. P. Martin before the Institution of Electrical Engineers (Great Britain), May, 1904.

Sometimes exhaust steam from non-condensing engines is used for heating workshops and factories in which or near which the engines are located, or for heating liquids in chemical or other works. In such cases, in considering the advisability of condensing, we have to take into account the cost of heating by other means in place of by the exhaust steam. The exhaust steam from turbines is especially advantageous in many cases owing to its freedom from oil. Similarly, if we wish to compare a non-condensing engine, the exhaust steam from which is used to heat the feed water to say 200 degrees F., with a condensing engine, we must allow for the fact that the condensing engine will provide feed water from the hot well at a considerably lower temperature than 200 degrees F.

The importance of getting cheap condensing water for large power stations employing steam engines will be appreciated by considering the amount of condensing water required by a large power station. The condensing water required by each of the large reciprocating engines at the power station of the New York Rapid Transit

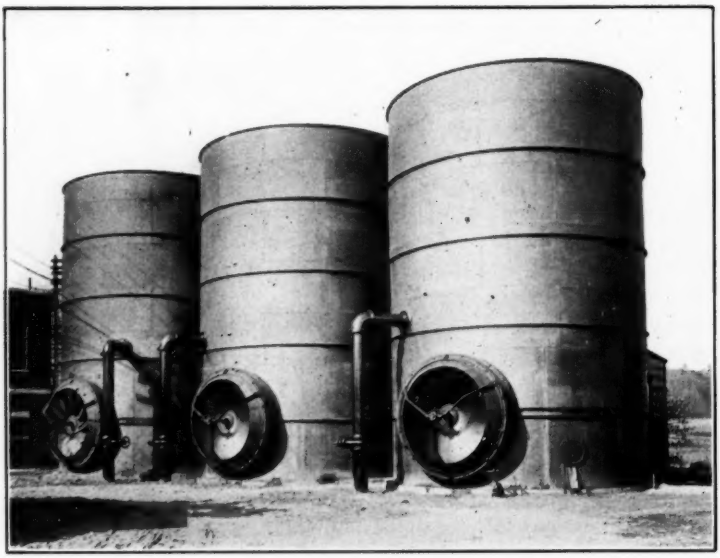


FIG. 7. COOLING TOWERS AT POWER HOUSE OF BOSTON & WORCESTER STREET RAILWAY CO., FRAMINGHAM, MASS.

Designed to cool the water for an Alberger counter-current condenser handling the steam from a 2,000-kilowatt Curtis turbine. Vacuum 27 inches. Each tower has two fans, driven by electric motor. Alberger Condenser Co., New York.

Subway amounts to about 400,000 gallons per hour when the engine is working at its maximum capacity, and there are nine such engines besides steam turbines. The vacuum pumps of this station are illustrated on the following page.

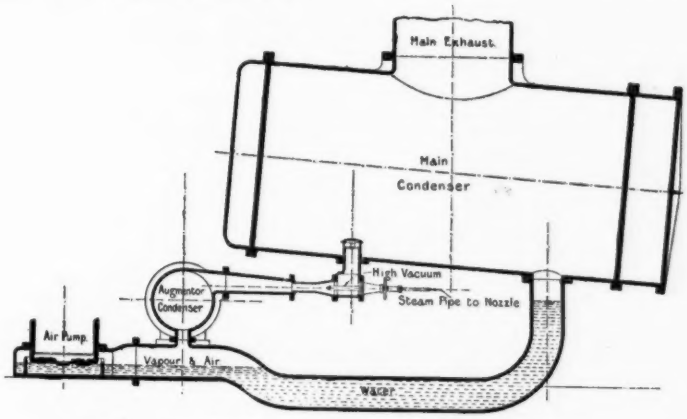


FIG. 8. ARRANGEMENT OF PARSONS VACUUM AUGMENTOR.

An important question to be considered in deciding on the condensing plant for power stations employing several units is as to whether each unit should be provided with a separate condenser or

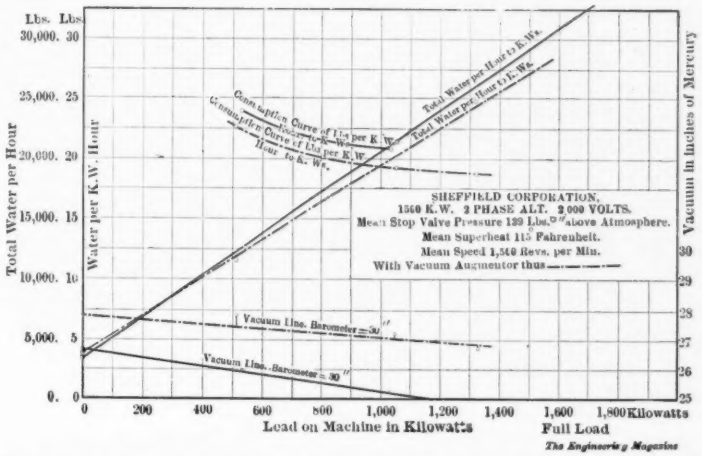


FIG. 9. SHOWING THE EFFECT OF A PARSONS VACUUM AUGMENTOR IN IMPROVING THE VACUUM AND REDUCING THE STEAM CONSUMPTION OF A STEAM TURBINE.

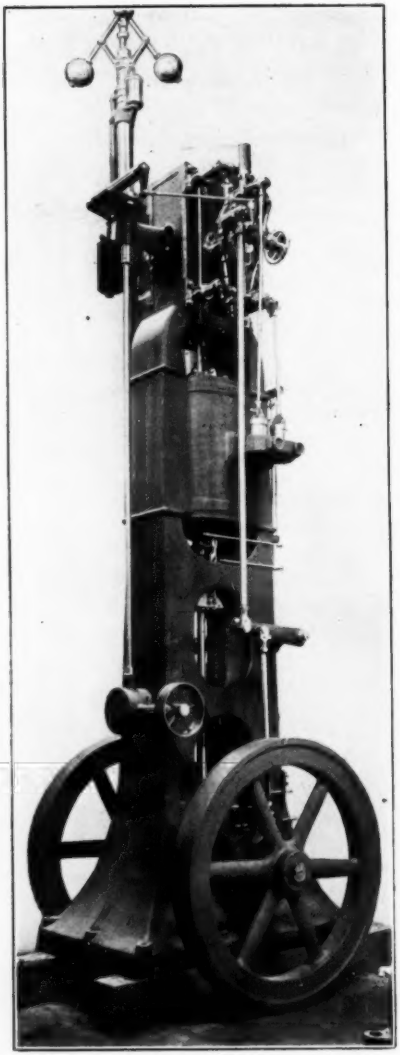
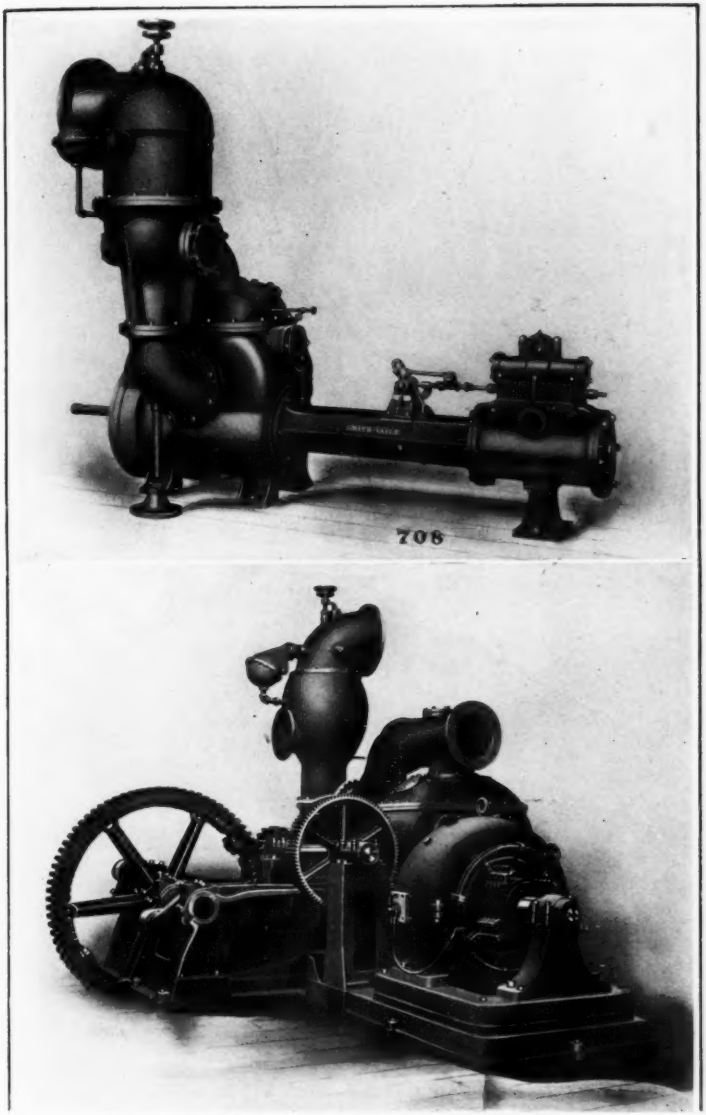


FIG. 10. VERTICAL DRY VACUUM PUMP. One of eight installed in 59th St. ("Subway") power house, Interborough Rapid Transit Co., N. Y., used in connection with Alberger barometric condensers attached to reciprocating engines of 10,000 h. p. each. Alberger Condenser Co., N. Y.

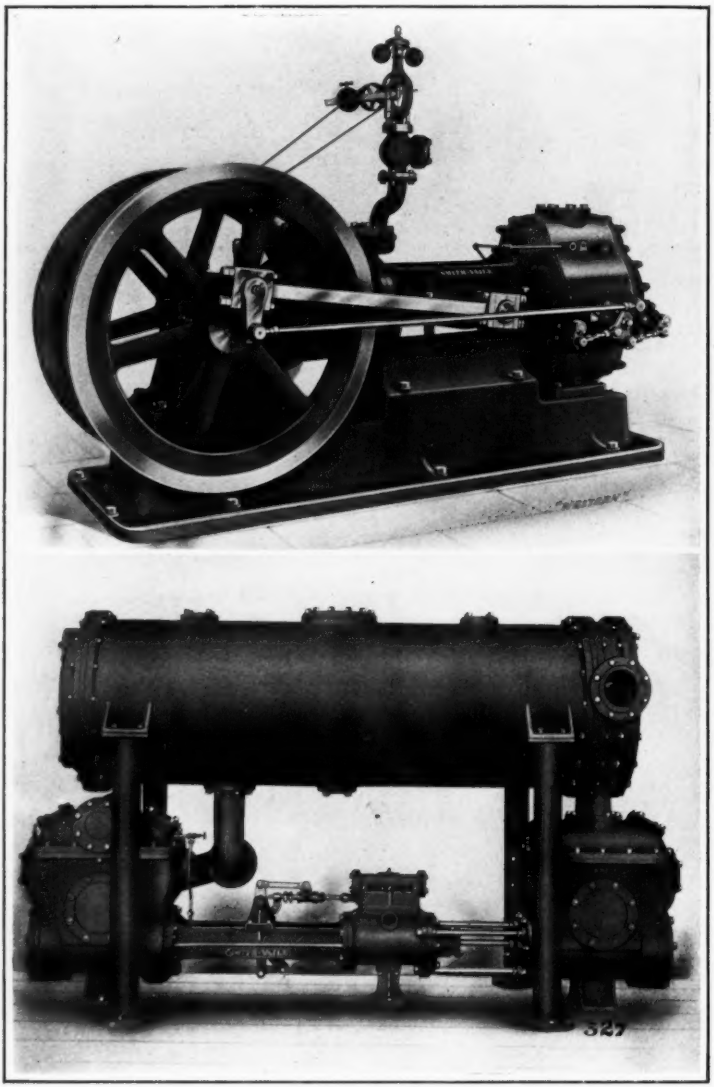
whether a centralised condensing plant should be installed to serve for all the units. There is a saving to be derived from employing a centralised plant, especially where the units are of small or moderate dimensions. One objection to the employment of a centralised plant is that, if any mishap occurs to this, all the engines are affected, whereas a mishap to a single condensing plant where each engine has its own, affects of course only one engine. The use of a centralised condensing plant does not however involve the risk of having all the engines stopped, as would be the case if all the engines got their steam from one boiler and that boiler was put out of action. Each engine should be provided with means for exhausting into the atmosphere whenever necessary.

In many cases where each engine has its own condensing plant it is advantageous to cause the engine to drive the air and circulating pumps. In other cases, however, this is not at all good practice. With rolling-mill engines, winding engines for pits, and other engines in which the full load comes on almost instantaneously when the engine is



FIGS. 11 AND 12. EXAMPLES OF COMPLETE CONDENSER SETS.

The upper figure is a Smith-Vaile single jet condenser; the lower, a duplex motor-driven jet condenser. Both are made by The Platt Iron Works Co., Dayton, Ohio.



FIGS. 13 AND 14. CONDENSER INSTALLATIONS AND AUXILIARIES.

The lower figure shows a surface condenser combined with air and circulating pump. The upper shows a dry vacuum pump furnished for installation with surface and barometric tube condensers. The Platt Iron Works Co., Dayton, Ohio.

started, it is very important if condensing is employed to have the air and circulating pumps independently driven so that the main engine can start with a good vacuum.

Prof. Rateau is responsible for a scheme which is in use at the Bruay Colleries (Pas de Calais) and which appears to give good re-

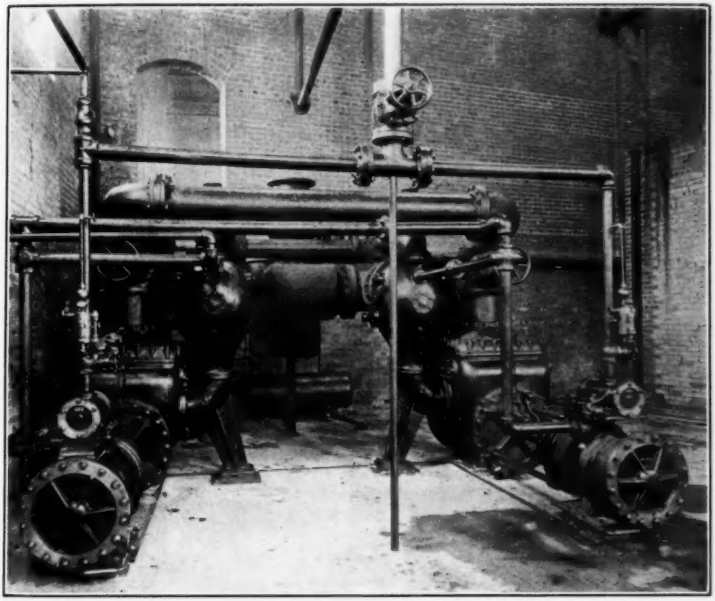


FIG. 15. TWO UNIT CONDENSER INSTALLATION, STANDARD SANITARY MFG. CO., NEW BRIGHTON, PA.

Two 18 x 22 x 24 Burnham jet condensers, taking care of condensation from one Corliss engine 20 by 42; two Skinner compounds 13½ by 24 and 10½ by 19 by 18; one compound high-pressure air compressor, 15 by 28 by 16, and one non-compound compressor, 14 by 18. All steam at 125 lb. Average temperature of condensing water 80° F. Average capacity of each condenser 20,000 lb. per hour. Installation by Union Steam Pump Co., Battle Creek, Mich.

sults. The winding engines all exhaust at atmospheric pressure, and the steam is conveyed from each engine to a central accumulator which supplies the steam continuously at about atmospheric pressure to a steam turbine employed to drive an electric generator. The accumulator is filled partly with steam at the saturation point and partly with water on the point of boiling. The steam and water have a large surface of contact; and the consequence is that a small rise or fall of pressure in the accumulator due to the intermittent nature

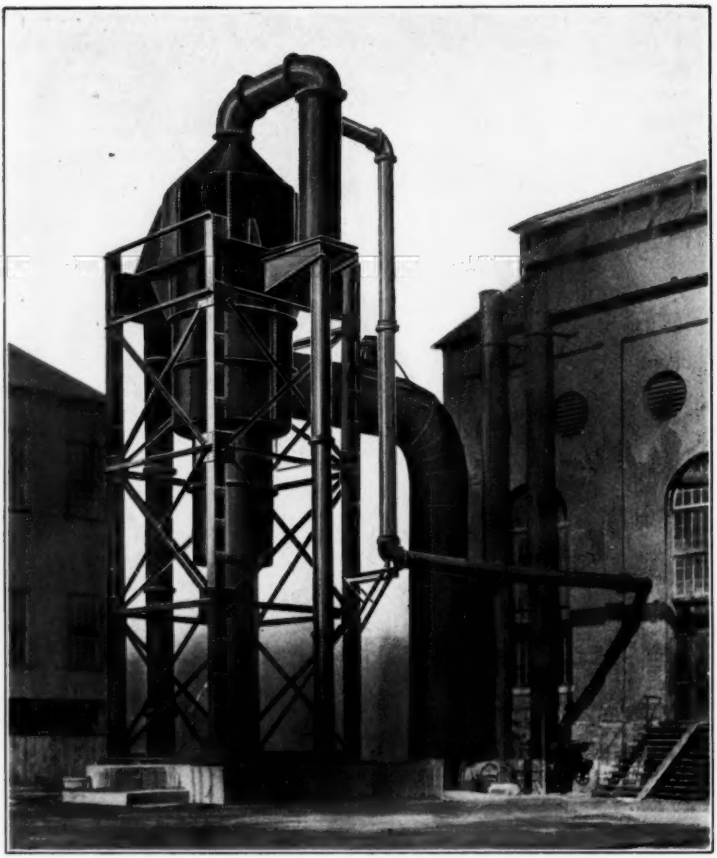


FIG. 16. WEISS CENTRAL COUNTER-CURRENT CONDENSER, SOUTH WORKS OF ILLINOIS STEEL CO., CHICAGO, ILL.

Capacity 30,000 lb. of exhaust steam per hour. Built by Southwark Foundry & Machine Co., Philadelphia, Pa.

of the supply of steam from the winding engines causes steam to condense or water to evaporate so that the turbine can receive a continuous supply of steam, although this varies a little in pressure.* An arrangement like this is preferable to running the winding engines

* See paper by Prof. Rateau read before the North of England Institute of Mining and Mechanical Engineers at Newcastle-on-Tyne, Dec. 13th, 1902, or paper by the same author read at the Chicago joint meeting (1904) of the Inst. of Mech. Engineers (Great Britain) and the American Society of Mechanical Engineers.

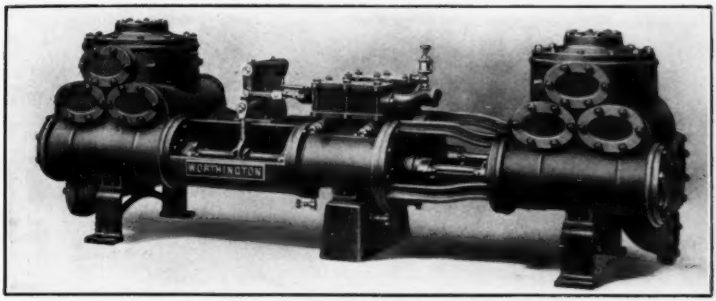


FIG. 17. WORTHINGTON AIR AND CIRCULATING PUMP.
One steam end drives both pumps. International Steam Pump Co., New York.

condensing and employing a centralised condensing plant, in so far that much smaller exhaust pipes are required; and this scheme is therefore practicable in many cases where it would hardly pay to convey the steam from the several engines to a centralised condenser. Even in power stations, the great amount of large diameter piping required for a centralised condenser is a serious objection.

The power required to drive the air and circulating pumps of the condensing plant of a large engine (above 500-horse-power) to give the engine an exhaust pressure corresponding to vacuum of 27 inches of mercury with the barometer at 30 should be under 3 per cent of the effective power of the engine, and in many cases a better vacuum

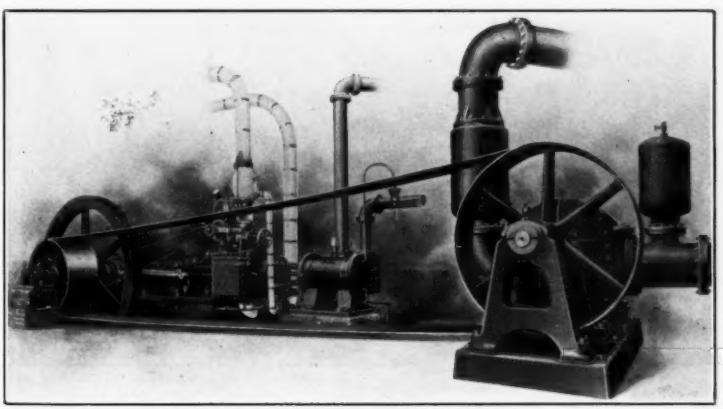


FIG. 18. STANDARD OUTFIT OF AUXILIARY MACHINERY FOR WEISS COUNTER-CURRENT CONDENSERS.
Built by Southwark Foundry & Machine Co., Philadelphia.

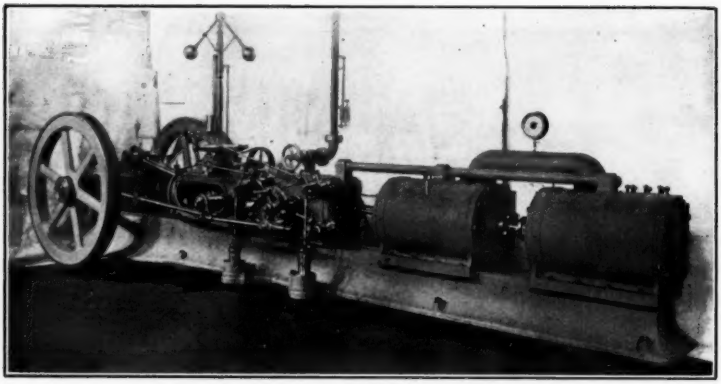


FIG. 19. CORLISS TWO-STAGE DRY VACUUM PUMP.

Used with condensers of both surface and barometric type. Vacuum cylinders compounded to enhance efficiency. Alberger Condenser Co., N. Y.

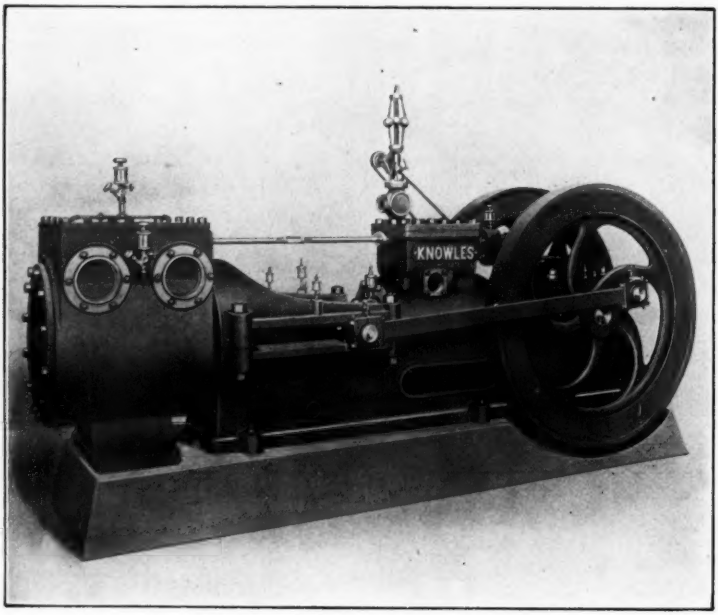


FIG. 20. ROTATIVE DRY VACUUM PUMP.

Adapted particularly to central condensing systems. Suction valves of vacuum cylinder positively actuated by eccentrics. Vacuum cylinders cooled by water jackets. For high steam pressures the steam cylinders are provided with Meyer cut-off valves. International Steam Pump Co., New York.

than this is obtained with an expenditure of only about 2 per cent. of the effective power of the engine. The power absorbed by the pumps increases very rapidly as the height of the mercury column representing the vacuum in the condenser approaches the height of the barometer. This is especially the case if the temperature of the cooling water is high. An increase of vacuum from 24 inches of mercury to 28 inches when the barometer is at 30 inches may easily double the power absorbed by the pumps, and with high-temperature water it will more than double this.

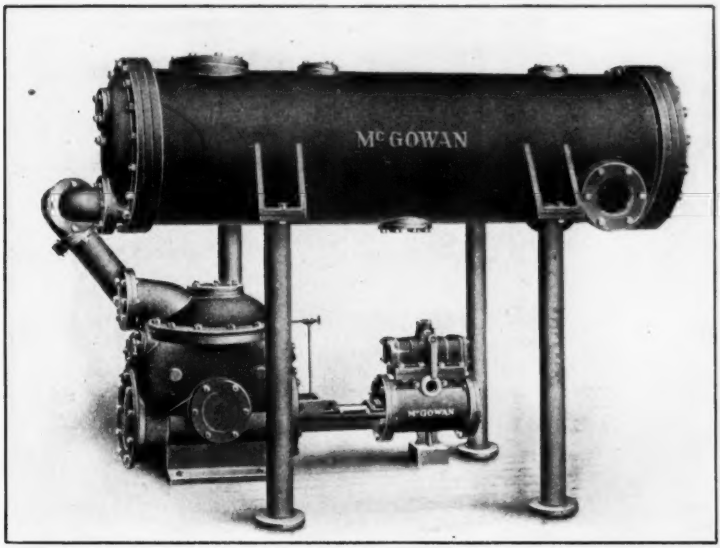


FIG. 21. CENTRALIZED CONDENSING INSTALLATION FOR TWO PUMPING ENGINES.
Steam-tube type, 650 sq. ft. tube surface, in combination with 8 by 12 by 12 single air pump. Cooling water may be by-passed from discharge lines of either or both pumping engines, permitting operation of either one singly. Condenser is of capacity sufficient for both at full load. Installed at Bessemer, Ala., water works plant by John H. McGowan Co., Cincinnati, Ohio.

In cases where water for condensing purposes has to be pumped up a considerable height, part of the power required for raising the water may be obtained by utilizing its energy after discharge from the condenser to drive a turbine or water wheel. This may allow of a considerable saving in the cost of working and may permit condensing engines to be employed with advantage in cases where they otherwise could not. This plan was adopted in connection with the

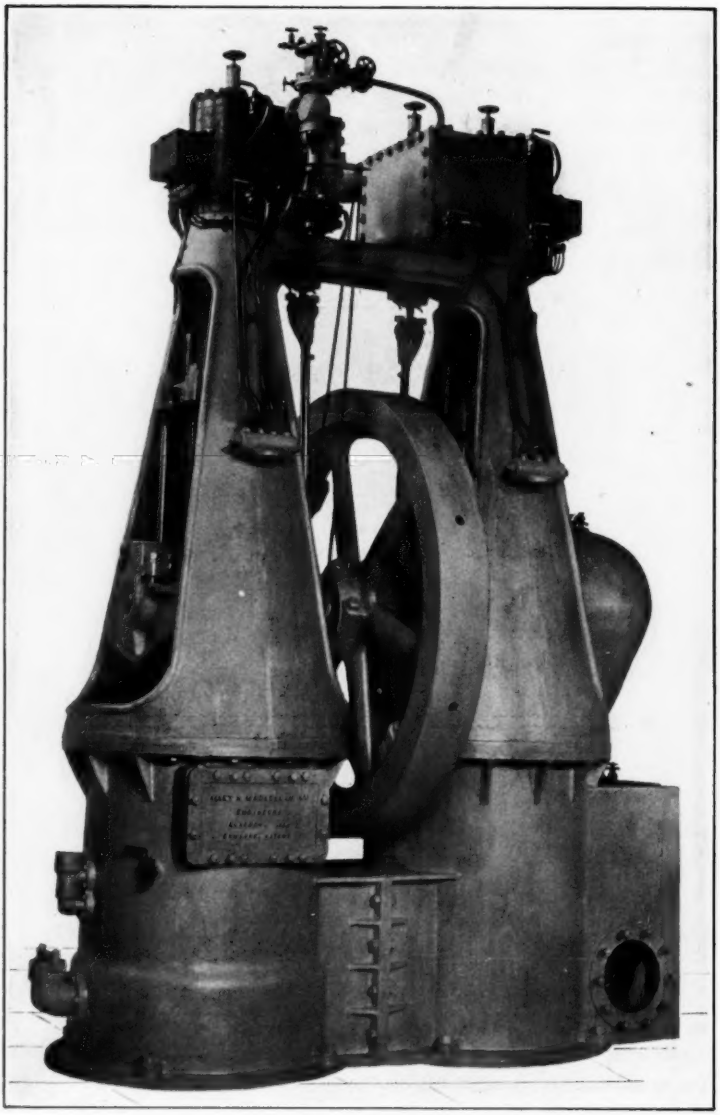


FIG. 22. CIRCULATING PUMP AND EDWARDS AIR PUMP DRIVEN BY COMPOUND STEAM ENGINE.

Alley & Macfellan, Ltd., Glasgow.

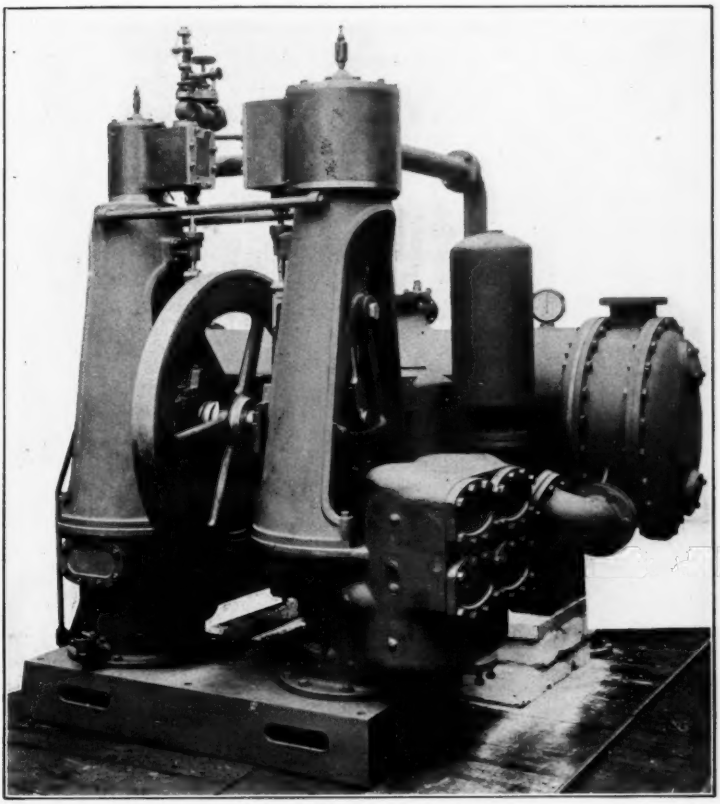


FIG. 23. STEAM-DRIVEN AIR AND CIRCULATING PUMP.
Frank Pearn & Co., Ltd., Manchester.

Newcastle-on-Tyne Tramway Power Station, where the condensing water is pumped up from the River Tyne to the engine-room, a vertical height of 86 feet. Centrifugal pumps are employed, each being direct coupled to and driven by an electric motor and a hydraulic turbine. Tests made on one set (pump, turbine and electric motor) at the makers' works (Messrs. Mather & Platt's) seemed to show that about 43 per cent. more electrical energy would have been required if the turbine had not been used.*

Some pumps have already been described. Figure 22 shows a

* Paper read by Chas. Hopkinson before the Inst. of Mech. Engineers, July, 1902.

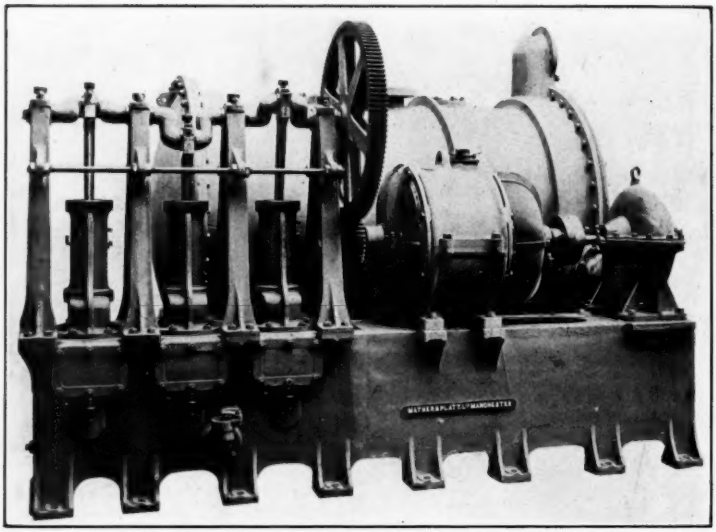


FIG. 24. SURFACE CONDENSER WITH EDWARDS AIR PUMP AND CENTRIFUGAL CIRCULATING PUMP.

Mather & Platt, Ltd., Manchester.

set of air and circulating pumps manufactured by Messrs. Alley & McLellan, Ltd., of Glasgow, to work with a surface condenser for the Sunderland Corporation Electric Lighting Works. The pumps are steam driven, the steam cylinders being seen at the top of the figure, and the pump cylinders at the bottom. The larger-diameter pump cylinder is the air pump. This is of the Edwards type and is 29 inches in diameter and 14 inches stroke. The other pump is for circulating the condensing water. It is double-acting and is 21 inches in diameter and 14-inches stroke. The compound steam cylinders work on the same crank shaft, which makes 60 revolutions per minute. The condenser has 4,000 square feet of cooling surface and is intended to deal with 30,000 pounds of steam per hour.

Figure 23 shows a set of steam-driven air and circulating pumps built by Messrs. Frank Pearn & Co., Ltd., of Manchester. The air pump is seen to the left and the circulating pump to the right, the two pumps being rigidly connected together and having a common crank shaft.

In Figure 24 is illustrated a surface condenser fitted with a three-throw Edwards air pump (seen to the left) and a centrifugal circu-

lating pump (seen to the right). This set was constructed by Messrs. Mather & Platt, Ltd., of Manchester, for a cold-storage warehouse. Both air pump and circulating pump are driven by the same electric motor, the former through gearing and the latter directly.

It is a pity that condenser pressures are usually expressed in inches of mercury of vacuum instead of as absolute positive pressures. A statement that the vacuum in a condenser or in the exhaust pipe from a steam engine corresponds to say 26 inches of mercury, lets us know only the difference between the pressure in the condenser or pipe and the atmospheric pressure at the given time and

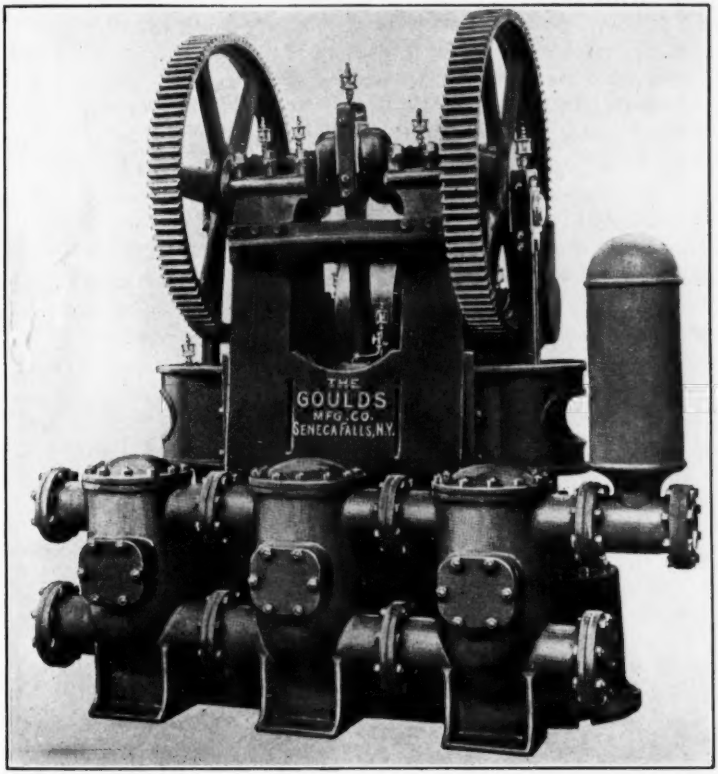


FIG. 25. A SINGLE-ACTING TRIPLEX PLUNGER PUMP FOR CONDENSER SERVICE.

To be driven by line shaft or electric motor; size 12 by 12 in. The Goulds Manufacturing Co., Seneca Falls, N. Y.

place, and we must know this atmospheric pressure before we can ascertain what is the actual pressure in the condenser or pipe in question. Moreover, when we are comparing two or more vacuums expressed as inches of mercury, even if we are given the height of the barometer in each case, if the height in the two cases is not the same, we have a calculation to make before we can get our comparison. When we are dealing with poor vacuums, the method of expressing does not much matter—that is to say, the statement "a vacuum of 20 inches of mercury" gives us a good idea of the state of affairs even if we do not know the condition of the atmosphere as indicated by the barometer. When, however, we are dealing with very good vacuums the case is very different—28 inches of mercury when the barometer is at 29 is a very different thing from 28 inches of mercury when the barometer is at 31; the pressure in the one case is three times what it is in the other. If the state of vacuum were always expressed by giving the absolute pressure, results could be compared with certainty and without any trouble and there would be the further advantage that the pressure would be expressed in the form usually tabulated along with the volume and other properties of saturated steam. For example, if the pressure in the exhaust pipe from a steam engine is given as being 1.5 pounds per square inch absolute, we at once find from a table of the properties of saturated steam that there are 1,117 British thermal units (reckoned above water at 32 degrees F.) leaving the engine for every pound of steam in the form of steam. If, on the other hand, the pressure in the exhaust pipe is expressed by giving the inches of mercury of vacuum, we have to make a conversion before we can read off the British thermal units.

METHODS FOR THE STARTING OF THE GAS ENGINE.

By Rodolphe Mathot.

IN the operation of a gas engine of the four-cycle type, there is first drawn into the cylinder the explosive mixture of gas and air which by its combustion is to develop the motive power. This charge is then compressed to a point varying from 70 to 170 pounds per square inch (5 to 12 kilogrammes per square centimetre). Next it is ignited, by a hot tube or an electric spark. As an obvious consequence, these internal-combustion motors are subject to the danger of a violent backward kick if, at the end of the compression, the gaseous mixture is exploded before the crank has passed the compression dead point. It therefore becomes indispensable, in the interest both of the avoidance of accident and of quick starting, to provide such motors either with a special device which will obviate the danger just indicated, or with an automatic starting system which will prevent the difficulty from arising.

Motors of low power—from one to twelve or fifteen horse—running on city gas or on benzine or heavier oil, are not in general fitted with any special devices. The workman in charge contents himself with turning the flywheel, either by his own effort or with the help of one or more assistants, until a proper explosion is secured, sufficient to turn the shaft at a speed which will overcome the frictional resistances and produce the necessary compression leading to the next explosion. This procedure, while primitive and tiresome, is likely to remain long in use so far as small motors are concerned.

Caution should, however, be given, in every case, not under any circumstances to attempt to move the wheel by bearing down with the foot upon its arms. Most of the accidents which have occurred in starting internal-combustion engines have arisen from this faulty and dangerous practise. The wheel should be turned only by pulling by hand upon the rim.

Motors in which the compression exceeds 80 to 100 pounds per square inch (6 to 7 kilogrammes per square centimetre) are generally provided with a so-called "relief cam." This operates by opening the escape valve for an instant, just at the period of compression, thus

allowing part of the mixture to escape. The pressure is thus kept within limits which can be overcome by the hand turning of the flywheel, and the piston can be forced to the end of its stroke in the cylinder. To avoid the inconvenience of pulling on the flywheel, there have been devised systems of hand cranks operating on the crank shaft, constituting a sort of safety appliance by which is avoided all the danger arising from an unexpected back stroke of the engine.

Designers and constructors of internal-combustion engines have given considerable attention to the matter of greater convenience in starting devices, and the results are apparent in a number of systems arriving at practically the same result. Among these might be instanced an arrangement of piping, provided with cocks, by the manipulation of which a certain charge of gas, drawn from the supply main, may be introduced into the cylinder of the motor at rest. The piston is previously brought into the proper position, and behind it is formed a mixture of gas and air which ignites on contact with a naked flame supported near a suitable orifice. An explosion results, automatically closes the ignition orifice, and gives the piston the initial power stroke. The motor, thus started, continues in operation by the regular sequence of its cycles. The start in this case is made without previous compression of the first combustion charge of gas and air. Other constructors have conceived of the use of hand pumps, compressing into the cylinder a mixture of air and gas or inflammable vapor, which should then be ignited at the proper moment by turning a cock which would bring it into contact with the ignition device.

The means just described are not of the highest possible efficacy. They require on the part of the operator a certain facility of manipulation which can only be acquired with time. They have, further, the disadvantage of giving an impulsion of sudden violence to the piston, the crank shaft, and the flywheel at the moment of starting. This results in injuries from hammer blows in the journals and from torsional strain in the shaft. Further, when the motor is operating with lean gas, the method of ignition without previous compression is inapplicable and the second system described is of very uncertain action. Thus these methods have given way, by degrees, in favor of the use of compressed air.

The operation of compressed-air apparatus is far more simple and certain than that of the devices just described, and less dangerous. The principal feature of the necessary apparatus is an air reservoir of iron or steel plate, heavy enough to carry a pressure of 12 to 15

atmospheres (170 to 200 pounds). Its volume should be sufficient to provide for several successive starting charges without refilling. It is connected with the motor cylinder by a system of piping which differs in arrangement according as the air reservoir is to be filled by the motor itself, acting as a compressor, or by an independent compressor separately driven. In the former case, this pipe has a stop cock next the cylinder and a check valve admitting the air into the reservoir. By means of this arrangement, when the motor has been running and the gas is cut off, the opening of the stop cock will admit to the reservoir, with each compression stroke, the air drawn into the motor cylinder during the preceding aspirating stroke. When the motor, thus operating by flywheel inertia, begins to slow down below the point of effective working, the stop cock is closed and the gas-admission valve opened for a few revolutions, or until the motor is speeded up sufficiently to resume the charging of the compressed-air reservoir. When this is completely accomplished, all valves are tightly closed to prevent loss of air pressure by leakage.

In the case of independent compression, especially with motors of more than 50 horse power, the piping between the engine and the compressor is of necessity wholly separate from that serving for gas supply to the motor.

The reservoir being charged, the operation of starting the motor is as follows:— The relief cam is thrown into engagement, and the piston brought into the starting position, which corresponds to a point from 10 to 20 degrees in the direction of rotation, in advance of the rear dead point reached just after the period of compression. The cock of the compressed-air supply is then opened sharply, letting the air enter suddenly and quickly closed, and cutting it off when the impulse has been given, to readmit it again at the corresponding point of the next revolution. This manipulation is repeated several times, until the motor has attained a sufficient speed. Then the compressed air is finally cut off and the regular gas supply admitted.

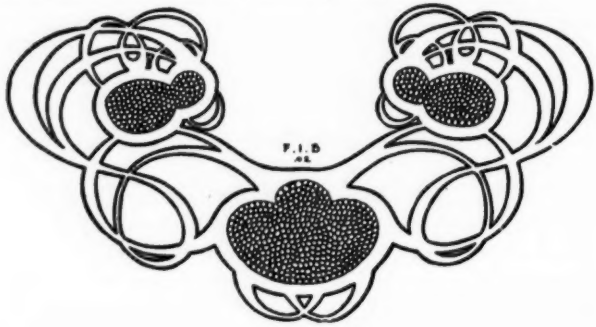
The air piping must be made perfectly tight, and the reservoirs must have a capacity in inverse ratio to the pressure they are designed to carry—that is, the lower the pressure of the supply they store, the larger they must be. For example, a reservoir normally carrying compressed air at a pressure of 100 to 120 pounds should be of at least five or six times the volume of the cylinder of the motor. If the reservoir is charged by the motor itself, the maximum pressure attainable in it is from 15 to 20 per cent lower than that of the compression of the cylinder.

Before any attempt is made to start the engine the ignition apparatus should be examined and prepared for its work. If the hot-tube system is used, the Bunsen burner, by which the tube is heated, must be lighted, the air supply to this burner being so regulated that the characteristic blue flame of complete combustion is obtained. The time required for the tube to reach the bright red heat varies with the material of which it is made; usually five to ten minutes will be found sufficient. This time may be well employed in examining the oil cups and attending to the general lubrication system of the engine.

In the case of electric ignition, this being the method usually found on large engines, its performance should be tested beforehand. If the method employed is that of a battery and induction coil, the circuit should be completed and the flow of current observed, the hum of the vibrating interrupter on the coil being an indication of its action, the circuit should be made through the contact mounted on the intermediary shaft of the engine.

When the ignition apparatus is operated by a magneto it is not generally necessary to make an inspection every time the engine is started, as there is less liability to derangement in this case. The starting of the engine itself starts the magneto, but it is advisable to retard the production of the spark at first, in order to avoid premature ignitions.

When an engine has not been running for some days it should be turned over several times before any charge is introduced, in order to see that all is in running order. The same precaution should be taken if a start has not been successful, so that any imperfect mixtures of air and gas may be removed. In all such matters a reasonable degree of judgment should be employed, without which no specific directions can be expected to serve.



PERSONAL RECOLLECTIONS OF THE DEVELOPMENT OF THE ELECTRICAL INDUSTRY.

By Prof. Elihu Thomson.

The following article was originally delivered by Professor Thomson as an address before the body of apprentices of the General Electric Company in Lincoln Hall, West Lynn, Mass. The lecture was prepared in compliance with a request by Mr. Magnus W. Alexander, who is in general charge of the apprentices. It was stenographically reported as delivered, and as now first given out in printed form has been fully and carefully revised by Professor Thomson and adapted to the wider audience reached by the pages of this Magazine. We are glad to have the particular honor of being the only medium through which Professor Thomson's most interesting reminiscences are made available to the engineering profession at large.—THE EDITORS.

LET us, in opening what will be but a brief outline of the development of the electrical industry in Lynn, look back to the conditions about 1876. In that year the Centennial Exposition was held in Philadelphia. This was the first large exposition in the United States, and was in commemoration of the Declaration of Independence in 1776. I lived in Philadelphia at that time, and of course can speak from a very intimate knowledge of things as they were. To give you some idea of the difference between that time and this, I have simply to mention that during that exposition no buildings were kept open at night; there was no means of lighting such buildings at night with any kind of ease or safety. All the power that was distributed, nearly all the machinery the exposition possessed, was in one building—Machinery Hall—and the hall was traversed from the centre in four directions by enormous shafts, with enormous belts and pulleys driving every piece of machinery in that hall. The engine—a very large Corliss engine it was called—of 1,400 horse power, was geared by great wooden cogs to a jack shaft below, and that jack shaft, by bevel gear and belting, distributed power to the line shafting which ran the length of the building. This may give you some notion of the conditions of power supply. There was a railway running through the grounds; of course it was a steam road. Nothing else could have been thought of—nothing in the way of trolley cars; nothing in the way of electric railways.

Now, what did we find there in the way of electrical display? There were exhibits chiefly of telegraph instruments, and a small exhibit of telephones, but nobody believed that such an instrument

was of any account, although it was used for the first time during the Centennial Exposition to transmit articulate speech over a line, and Lord Kelvin, who was then Sir William Thomson, was one of the witnesses called to testify to the fact that it did transmit speech. Even then it was two years before the telephone became recognized as a useful instrument of communication. Just try to imagine what the limitations were at a time when it was impossible to light a large building with any ease and without danger; perhaps with gas lights; perhaps with candles; perhaps with kerosene. I should say, however, that there were but two exhibits in that exposition which concerned electric lighting. One of these was the Gramme Electrical Company's. The Gramme machine was made in Paris and was used to furnish current to a single arc light. Another machine, the Wallace-Farmer, was used at intervals to work another single arc light. A machine to work two lights, three, four or more lights, was unknown. There was a dynamo in the Gramme space (a little space, too), which drove as a motor another machine, and this motor worked a pump and ran a little water-fall. That was the first typical exhibit of the transmission of power by electricity in the United States, I think. It was the germ of a great industry. I was very naturally interested in all this—deeply interested. I had been building small dynamos, even before that time, and had experimented in a general way with electric lighting and so on, and I was much interested in seeing even these comparatively small exhibits.

In 1878, at the Paris Exposition, one of the streets of Paris—the Place de l'Opéra and the Avenue de l'Opéra—was for the first time lighted by a system called the Jablochkoff. In this system two carbon pieces were put up parallel to each other and the electric current passed across a white insulating material between. This was kaolin. This lighting created a very great sensation. Each of the large globes contained a number of the Jablochkoff candles, as these double carbon sticks were called, because these only lasted about an hour or an hour and a quarter, and when one was burned down the next had to be switched on, and so to the last in the globe. But they made a splendid effect for those times and attracted universal attention.

I was naturally interested, and went to Paris partly to see this exhibit. I made the trip abroad at that time to get all the knowledge I could in relation to this new electric development, but came away believing the Jablochkoff candle was not the thing for lighting; that it was beautiful but expensive, and not the direction in which it was

proper to work. On getting back I set about producing what was finally called the Thomson-Houston system, joining energies with Prof. Houston, who was, like myself, teaching in the Philadelphia Central High School at that time. He was professor of physics and I professor of chemistry. We produced a dynamo and lamps. My first machine, intended for running an actual electric light, was built in 1876, but was very moderate in size, and very small in the matter of light. I could, by the use of a foot lathe, get a small arc light out of it. By working very hard and perspiring a great deal I could keep the light going for about a minute or so. In 1878, however, I built a machine which was capable of giving about 120 volts and 10 amperes. I made the patterns and put the machine together absolutely without any planing, having only a foot lathe at command. The armature was made up of cast-iron discs strung on a wooden hub or shaft, yet the machine certainly worked and was shown in operation at the Franklin Institute during the winter of 1878-1879. It weighed about 350 pounds and was not only a continuous-current dynamo but would give alternating currents. One could take from one end of the shaft continuous current, or direct current, and from the other end alternating current. More than that, one could get alternating current in two-phase relation. It was, in fact, a two-phase alternating-current machine, self-exciting, and the old machine has been preserved in the model collection at the Lynn works. This machine was in reality the beginning of our actual arc-lighting work on which was founded this industry.

In 1878 this machine was shown, as I have mentioned, at the Franklin Institute. It attracted the attention of Mr. Garrett, a typical Philadelphia Quaker, who was then the agent of the Brush Company, which was just beginning to put out some few arc lights. A few machines were in use, giving two to four arc lights to the machine. I must explain here that these machines worked in this way; whenever you wanted a light you ran a separate circuit out and back to the machine. They were what we may call single-arc multi-circuit machines. One set of armature coils fed to this line, another this, and so on, and for four lights you had to have four dynamos in one. The idea of putting lights one after the other in series was not developed at that time. Mr. Garrett asked if we could get up a four-light machine that would run these single-circuit lights, and he was told that we would try. "Well," he said, "if you want to try I will bear the expense and see how you come out." So I set to work at once. Evenings and whole nights were

spent in getting information together and calculating out, as best I could, what that machine should be and how to build it in a small machine shop. I would not trust anybody to do the winding but myself. I personally wound the armature and the field and did everything necessary of an electrical nature to ensure that nothing would go wrong. It must be borne in mind that no armature winders were to be had in those days. It would have taken a great deal of superintendence to get any man to wind an armature correctly, or to do anything with insulated wire where the voltage was considerable. This machine was wound and run, and it gave four lights in four separate circuits. As the machine was being completed Mr. Garrett came in one day and said "Can you not run those lights on one wire? I hear that the Brush Company is doing it." "Oh yes," I said, "I can." We soon had them running on one wire, 20 amperes to each light. They were very large and very beautiful arc lights, such as are not often seen nowadays. The lights ran all night in a bakery, and soon after a number were installed in a brewery, and so the business began. The bakery was fearfully hot in summer and the temperature was about 140° in the room where the machine was running. We had to stay in it, and so got baked as well as the bread and the arc machine. But somehow or other the machine stood up, and we stood up also. Not long after the machine had been in operation another inquiry came from Mr. Garrett:—"Can you make that machine give half as much light per lamp and twice as many lamps, or can you put on more lamps and split the current up?" I said we could, for I had thought it all out before, believing it was coming; I did not wish to push him, but waited for him to push me in that respect, but the machine was all ready so that the circuit could be divided and made into what we called an eight-light 10-ampere series arc machine. For years after that the 10-ampere arc circuit was the standard, not only for ourselves, but for the other arc-light companies, with but one or two exceptions. The above conveys a general idea of how the Thomson-Houston arc system was started.

Mr. Garrett began to build machines after the first model and to sell them. One went into a brewery. An instance of something which happened there will show the way in which those new things were regarded at the time. We had established a seven-arc-light machine in this brewery, the proprietor, a good friend of ours, being willing to stake his lighting on our success. We were able to give him what he wanted, so put in the proper machinery and lighted this

brewery. One night, for some reason or other, the hay in the loft above the stable which was part of the building took fire. It was thought that somebody had been smoking there. The engineer at once shut down the lights, but the proprietor said, "No! No! Keep the lights on; I want to get the horses out." But when the firemen came, being unused to such lights, they played the hose on them and could not put them out. They were astonished to find that the globes could be full of water and that the light was still burning under water. Thus they learned that the electric light was different from other lights. There is no doubt in my mind that the fact that the electric light was kept going during the fire saved the building, because it enabled the firemen to work, and the only damage was in the upper story, in the malt room. The lights were run for a week or so afterwards with the wire lying across the burned portion of the building, so to speak. The circuit wire passed through this burned portion and still ran the lights. I mention this as an incident of the early days, when the nature of electric lighting was still little known.

It required, as you may well believe, a considerable amount of courage to start an enterprise of this kind; not knowing what market there might be for electrical apparatus. It required that we, as it were, should prejudge the future. But it seemed as if an era was opening in which electricity should have a great part—at least so it seemed to me—and shortly afterwards a company was organized to begin operations, in New Britain, Conn., and it was called the American Electric Company. It was formed for the exploitation of the system which we had been developing, and it carried on the work there for a year or two. The management was not very satisfactory at the start—was not pushing, not energetic—and the work dragged; but we kept at it and kept developing new things and perfecting our arrangements so that by the time the beginning of 1882 came there was a 25-light arc machine in existence and a number of appliances that made the system a very workable one—regulators, etc. In other words, we had, during this time of what one might call indifferent business management, thought it best to get everything in good shape so that we could make a creditable effect with our arc-lighting system, when a better business outlook presented. I may say here that our arc-lighting system was the thing we began with, and that alone—simply a dynamo, regulators and arc lights. In 1882 our lights were shown in Boston for the first time.

Just at that time it happened that two or three gentlemen of

Lynn, Mr. Henry A. Pevear, the first president of the Thomson-Houston Electric Company in Lynn, Mr. Silas A. Barton, the business manager, and a few others, were thinking of starting a little local electric-lighting company for supplying electric light to stores on Market Street and thereabout. They happened to see our lights which had been put up in Boston, and which were being run by a company that was really only a stock-jobbing affair. This company was using one of our lighting machines as its own. But the promoters did not remove the nameplate from the machine, as it happened, and Mr. Pevear and Mr. Barton saw that the American Electric Company, of New Britain, Conn., were the makers, and took a train for New Britain to find out whether apparatus of that kind could be purchased. They appeared at New Britain one day in 1882. I was there, as was also Mr. E. W. Rice, now of Schenectady, and at present one of the vice-presidents of the General Electric Company, and we received them. We told them that we did not know whether we could furnish them this apparatus or not. The majority of our stock had been bought out by the Brush Company, of Cleveland, and we did not know whether or not they might try to shut us up. "Well," they said, "can't we buy what the Brush Company have bought?" "Possibly you may," we said. To make a long story short, negotiations were begun and by the fall of the year 1882 the Lynn syndicate had purchased from the Brush Company such stock as was held by the Brush Company. At once the Lynn management set to work with great vigor to make up for lost time. I must give all praise to the energy and push of the Lynn management at that time. It came into the matter with courage and determination to make the enterprise succeed. It ran the shop in New Britain for about a year while factory "A" was being built in Lynn. As soon as this was built we were to pick up everything and leave New Britain and come to Lynn, all of which occurred in the fall of 1883. So the first appearance of this electrical industry in Lynn was in the fall of 1883.

We then had only factory "A." The lower floor we had for the heavy work, such as dynamos; the upper floor was for lamps and the middle floor for development work, pattern work, and drafting. Everything was packed into factory "A," and Mr. Pevear thought—this is a story which he laughs about nowadays—that we should not need all of this building. He said: "Well, this business may not need the whole of factory "A," but anyhow the upper floor can be used for drying skins." It was but a few months before not only did we

want all the floors there were in "A," but more room. "A" was loaded down from cellar to roof with all sorts of machines packed in closely everywhere, until it became doubtful whether the floors would withstand the weight, and I remember calling Mr. Baker's attention at one time to the floor weakening in "A" on account of overload. That was later on. But in these early days that was the condition—almost a serious risk from the weight there was in that building. This soon led, in 1886, to the building of factory "B," which gave considerable relief. Then we thought we had a great deal of room. It was not very long, however, before that building filled up, too. The top floor was the incandescent lamp factory, the middle floor the pattern shop, model room and office, and the lower floor was used for dynamo testing for some time. Factory "A" was given up to manufacturing parts almost entirely. Further on factory "C" was built and that was very soon filled; we kept on, as you know, and have now got pretty well along the alphabet, to factory R.

Now, this growth was of course not all the result of our original business of arc lights; it grew out of that business, but the Lynn management felt that we could not afford to tie ourselves down to any particular kind of application of electricity. We must take business of every kind that offered in the larger application of electricity. So after the arc-lighting system was completed and in use, and so on, the next thing developed was incandescent lights, adapted to run on the arc-light circuits, to run in series with the arcs on the arc machine. Then came incandescent lights on continuous-potential circuits, as they are called. This was an entirely new business for us. It took some time to get under way—a great many things had to be done. And here I wish to say that while this was going on the Edison Company was devoting itself almost entirely to incandescent lights, and was building up a business at Schenectady—the Edison Machine Works. Later on, when the incandescent-lamp works had got well started, came alternating-current work, about 1886. Before that time everything had been direct-current. Alternating current had very slight place—and in speaking of alternating current I mean alternating currents sent over the line at high pressures with transformers to reduce the pressure for local lines. The beginning of the transformer work, which, as you know, forms a large portion of our work today, was in 1886.

But one of the greatest changes took place in 1887. This was the year of the beginning of the railway work. Nearly all of the

cars before that time throughout the country were drawn by horses. The Crescent Beach line, one of the first trolley lines run by the Thomson-Houston Company, started in 1887. Very soon after that a line went over the Highlands through Lynn, the test being to see whether the trolley car could climb the heavy grades and make trips regularly without trouble. It was demonstrated to be feasible, and from that time the business of trolley-car introduction on electrical railways increased enormously.

Here I wish to say something about the spirit which existed in our organization. The management was always ready to recognize merit outside of the organization. There might be merit inside it, but the recognition of outside merit was just as ready as of that inside. It was found that Mr. Charles J. Van Depoele had been working on electrical apparatus in Chicago and had made considerable success in a way, without real financial return, and that Mr. Van Depoele was getting somewhat discouraged. We were quite ready to take Mr. Van Depoele under our wing and give him that encouragement which he needed. He had done considerable pioneer work which even at this day is found in electric railways. He was the originator of what is called "the under-running trolley"—that is, the little wheel on the pole running under the wire. There was run by him, I think in 1885, a short line in Toronto, on that plan. Before that time it had been the regular custom to run the little wheel on top of the wire—the over-running trolley, it was called—a kind of little car that used the wire as a track, with a cable led down to the car below. Sometimes the little car had two tracks, that is, an outgoing and a return wire were placed above the track and the little car rolled over these two—that was the over-running double trolley. I do not want to make these reminiscences too tedious, but I wish to say that the railway business grew far more rapidly perhaps than almost any other business undertaken. Then came along meters and other devices in endless series. We know that we have continued the same proportion of growth and development right along, and of course we hope that we shall never see the end of the extension and development, and I do not think we shall.

Later came a large development in stationary motors and the use of cast steel for motors and dynamos. Previously cast iron was the thing used in making all the frames of motors and dynamos. Cast steel could not be obtained. I remember distinctly writing to steel manufacturers around the country, asking if we could not get castings of such and such a shape of cast steel, and they said that steel could

not be cast that way. Finally, we had to put up our own steel foundries.

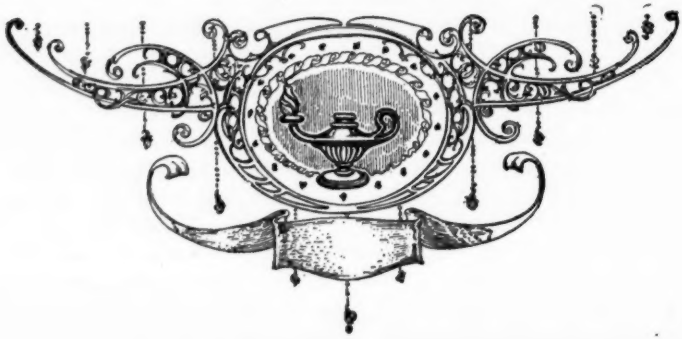
Now, in 1891, or about that time, came a great change. The Thomson-Houston Company here had achieved a great reputation and was a very active company. The Edison Company in Schenectady was doing a large portion of the business. An interesting fact, however, is that the Thomson-Houston Company, which had formerly been in the hands of the Brush Company, as I have told you, before the Lynn people became interested in it, had bought out the whole Brush Company—had turned the tables and bought out the Brush Company and factory at Cleveland. Then shortly came the great consolidation which made the General Electric Company. "Why did such a consolidation appeal to the managers of the companies and others interested?" you may ask. Well, there was a large amount of money expended in competition with each other's business and in litigation, the outcome of which was uncertain, and so consolidation seemed the most natural thing in the world. One company was doing a large business in its own particular line, another doing a big business in the same and different lines, and it was inevitable that they should severely compete, both in the market and in the courts. Business was impossible, in the best sense, when a great deal of money and talent which ought to go into dividends was being expended in legal combats or used in destructive warfare in the commercial market. Under these conditions the companies came together and the union of interests was perfected.

Mr. C. A. Coffin, now the president of the General Electric Company, had been active in the management from the start at Lynn, and was at the head of the Thomson-Houston Company at the time of the consolidation. It is not too much to say that to his energy and resourcefulness much of the successful building up of the enterprise was due.

Now, what have we to look for in the future? Is this great growth that I have outlined—in the briefest possible way, I must confess—going to go on? I think so. But what I wish to impress upon the young men in the electrical profession is that as you grow up you will find no really good result is ever obtained unless you are willing to exert yourself for it. In our early days we had lots of trouble, hard fights and plenty of difficulties to overcome in establishing this industry. Sometimes it has been hard to overcome obstacles or even prejudices against new things. Trolley lines were not adopted without such struggles. I recall being cross-questioned in

no very gentle way because I favored the introduction of the trolley line for Boston, as to whether people would not be killed or this disaster or that or the other calamity follow. I am happy to say that I was able to answer most of such inquiries and to satisfy those in control that there was not going to be any disaster following the introduction of the electric railway in the streets. In the early days, in 1882, as I have told you, we were bought out by the Brush Company. That was a time of discouragement. We did not know whether we were going to be shut up or to go on with the business. But, fortunately, owing to the little accident of the Lynn people seeing what we were doing, the scale was at last turned and we began operations afresh with renewed courage, and of course with eventual success. It is indeed something to belong to; to be connected with, an organization which has in so short a time grown to the magnitude and importance of our electrical industry.

When the consolidation came, the top floor of "B" was used for the manufacture of incandescent lights, but afterwards the whole of this work went to the Edison lamp works at Harrison, N. J. But our men went there, too, and they introduced the methods which had been pursued here, with the result that the incandescent lamp was much improved in a short time. You can see the benefit of bringing the two organizations together. The methods applied in two separate works have been combined and work of a higher standard than either could have reached in a short time separately has been the result. The incandescent lamp of today is enormously better than the best made in those early days. This is the result of the union of effort, and it is to union of effort in many lines that we have to look for advancement in the future.



EDITORIAL COMMENT

THERE is a very general disposition to suspend the interpretation of Japan's overwhelming naval victory until much fuller data are available than have yet been received from the Far East. Judging by the precedent set and rigorously maintained by Japan since the beginning of hostilities, we may not expect a very ready willingness to give out the details of Togo's tactics leading up to the battle, and for the present must rest as content as possible with his ascription of the results to the resplendent virtues of the Mikado. The deduction from analogy is that the Russians were defeated by the vices of the Czar.

And after all, this flower of Oriental expression has a root of solid fact. The one thing which is perfectly clear even now, and which is more fundamental than any point of strategy or tactics, is that the Japanese victory was the logical result of a super excellent order of honesty and devotion in the nation of which the Mikado is the formal head, while the Russian rout is the equally logical end of national dishonesty, official corruption, and "graft" run rampant. Rojestvensky was defeated before he sailed from the Baltic, by the rottenness bred in the Russian court and spread through almost every institution of the country, sapping its physical strength and destroying its moral fibre. Russia, once the giant of the nations, has been exhausted to the point of collapse by systematic, unchecked dishonesty in high places.

* * *

THERE is a grave suggestion in this which we may take home, for we too as a nation are cursed with graft. Corruption, favoritism, incompetency, are regarded as quite normal in the political administration of our public affairs, and almost no one attempts to "do anything about it." Finance is nearly —and "high finance" is quite—synonymous with trickery, and the world shrugs its shoulders at the disclosures. The managers of one of the greatest of our fiduciary institutions are discovered in transactions of a kind for which their butler or coachman would be dismissed in disgrace, and their course is aggressively and indignantly defended on the ground of custom and precedent. It is hard to say whether the indifferent pessimism too often shown by the public is not a worse danger than the evil of dishonesty itself. But fortunately the public conscience is not dead, and the public indignation not at all beyond awakening. Philadelphia and the Equitable Life scandal have shown that honesty, of the kind dubbed "old-fashioned" by party bosses and modern financiers, still lives in the masses; and when aroused it is powerful enough to sweep bosses and financiers, however loudly protesting, from their grasp of power and into acceptance of its dictates. To this recovery Russia also will come, but by steps it may be fearful to contemplate. In the freedom with which public opinion is expressed, and in the power which it exercises without violence, lie our National safety. The conservation of that safety depends upon the assertion and the exercise of the National conscience before the conduct of any class has become fatally separated from the sound standards of morality of the masses.

THERE has been recently expressed some degree of anxiety in various quarters as to the probable durability of the modern tall building, and numerous alarmist statements have appeared from time to time in the sensational press representing the skeleton-steel structure as trembling to decay before the invisible actions of corrosion, vibration, and general molecular degradation. The absurdity of these forebodings will be realized when it is appreciated that the demands upon the steel structure are far within its capabilities of resistance. So far as vibration is concerned, there is not a steel ship afloat which is not subjected to buffetings before which the slight tremblings of the tall building are microscopic; and the modern ocean liner is twice the length of the tallest building in existence, the Eiffel tower alone excepted. No one fears the failure of the metal in the steamship, because every one realizes that long before any appreciable deterioration can occur the great liner will have been relegated to the junk yard and the scrap heap, superseded by a swifter vessel, of a newer model, and greater capacity. The tall building is in a similar position. There now stands, in the city of New York, a modest structure of eleven stories in height called, since the time of its construction in 1888, the Tower Building, because it rose at that time like a tall watch tower above the smaller houses in lower Broadway. This was the first of the modern tall buildings in which the weights were carried upon a structural skeleton, instead of requiring heavy walls of masonry to bear the burden and transmit it to a limited foundation area. Today the Tower Building is lost amid the far greater structures between which it is sandwiched, and having outlived its usefulness, it is to be torn down to make way for a new structure of more than double the height.

We have thus the interesting fact that the first tall building, regarded in its day as a marvel of engineering audacity, has lived its life in the short space of seventeen years, not because it is worn out, or unsafe, or in any way objectionable, but simply because it cumbereth the ground, so to speak, because it is not tall enough, because it has outlived its usefulness! The buildings of past ages which have remained are extremely few, and with the exception of a small number of monumental structures, the most massive erections of masonry have given place to newer buildings, better adapted to the requirements of their surroundings. The modern tall building is no exception; it will fill its place in the passing conditions of life, commerce, and industry, and make way in its turn to something developed by the constantly changing environment.

* * *

WE referred in the last issue of the Magazine to the question of high-speed railway trains, and almost before the ink was dry upon the page came reports of still swifter trains, reducing the time between New York and Chicago from twenty hours to eighteen, and even to sixteen hours! There appears to be little doubt that the question of railway speeds depends more upon the condition of the road-bed than upon the locomotives, and given a clear track and a sufficiently substantial superstructure, there appears to be no good reason why the speeds made upon the military railway between Marienfelde and Zossen should not be repeated in daily service. The whole matter is a commercial question—a question of a sufficient number of passengers.

At the same time it must not be forgotten that more time is wasted at the terminals every day, with every train, than is gained by these forced speeds upon the road, and it is at the ends of the line, and not in the middle, that the most time is to be saved.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

INDUSTRIAL ENGINEERING.

THE WORK OF THE MODERN ENGINEER CONSIDERED AS AN ECONOMIST AND INDUSTRIAL ADMINISTRATOR.

Henry R. Towne—Purdue University.

THE early conception of the engineer was that of a man who planned things, mechanical and otherwise, and also attended to their construction and operation, and it is only within recent years that he has been supposed to have anything to do with the commercial side of the works which he has so largely created. Now, however, the scope of engineering work has been immeasurely broadened by reason of its development to include the control of administration, and in this way the engineer has come to realize that he must also be a man of business and affairs, and that his work must be well done, not only from a technical viewpoint, but also from the position of commercial success.

In an address recently delivered before the faculty and students of Purdue University, Mr. Henry R. Towne, himself well known as an engineer and as a successful business man, this important subject of industrial engineering is brought out in a very effective manner.

Mr. Towne clearly states than the question of cost must be taken as the controlling one in nearly every instance:

"The *dollar* is the final term in almost every equation which arises in the practice of engineering in any or all of its branches, except qualifiedly as to military and naval engineering, where in some cases cost may be ignored. In other words, the true function of the engineer is, or should be, not only to determine how physical problems may be solved, but also how they may be solved most economically. For example, a railroad may have to be carried over a gorge or valley. Obviously it does not need an engineer to point out that this may be done by filling the chasm with earth, but only a bridge engineer is competent to determine whether it is cheaper to do this or to bridge it, and to design the bridge which will safely and most cheaply serve, the cost of which should be compared with that of an earth fill. Therefore, the engineer is by the nature of his vocation, an economist. His function is not only to design, but also so to design as to ensure the best economical result. He who designs an unsafe structure or an inoperative machine is a bad engineer; he who designs them so that they are safe and operative, but needlessly expensive, is a poor engineer, and, it may be remarked, usually earns poor pay; he who designs good work, which can be executed at fair cost, is a sound and usually a successful engineer; he who does the best work at lowest cost sooner or later stands at the top of his profession, and usually has the reward which this implies."

At the present time nearly all the engineers who have attained success in the art of combining the scientific and commercial departments of work have acquired their knowledge in the hard school of experience. The technical schools teach the science of engineering in a thorough and effective manner, but they turn their students out into the world of practice with little or no knowledge of that most important side of their profession, the in-

dustrial department. Mr. Towne emphasises this point, and refers to the absence of text books and literature adapted for instruction in this important department of education. It is encouraging to see that this matter is receiving attention, and in various quarters there has appeared of late a demand that portion of the training of the engineering student should include the elements of such things as cost keeping, expence accounts, the influence of depreciation, of scrapping upon design, etc. These, and all the related details of industrial engineering should form as much a portion of the equipment of the trained student as a knowledge of the strength of materials, the principle of mechanics, the laws of thermodynamics, or the science of electricity.

"Industrial engineering is the practice of one or more branches of engineering in connection with some organized establishment of a productive character, in which are conducted the operations required in the production of some articles, or series of articles, of commerce or consumption. Nearly all industrial work of this kind, especially if it be conducted on a lrge scale, involves technical, physical, and engineering questions, varying with the kind of industry but usually of wide scope. For instance, in steam engine building, it is primarily a question of thermo-dymamics and steam engineering, but it involves equally the question of the selection and right use of machines, tools, and methods of production. So likewise in electrical work, the textile industries, and all the range of our manifold industries. On its technical side each has its special and distinctive features; but on its administrative side each involves certain fundamental elements which are common to all. The technical work may be in charge of a technical man, responsible for that work only. The administrative work may be in charge of another man, not fortunate enough to have had a technical training, but a good administrator. If these two work in harmony a good result should follow. But a better result in every way will be reached where these two functions are combined in one person; where one master mind knows both the technical side of the work and how to select and direct the men who shall attend to its details, and who also has the ability and the training needed to qualify him to direct and control the work of administration. The union of these two functions in the one individual constitutes the best kind of material with which to fill leading positions, the kind of material the captains of industry are always looking for."

The pages of this magazine for the past ten years show the interest which has been taken by professional and practical men in the vital question of the relation of engineering to cost keeping and industrial accounting, and Mr. Towne lays especial stress upon this feature of modern administrative engineering.

"One of the essential elements in industrial management and enginering is industrial accounting. It is a common mistake to look upon the accountant in an industrial organization as of little importance, and his work as simply requiring ordinary intelligence, with little or no special training. Even if true as to routine commercial accounting, which usually deals only with the keeping of salesbooks, journals and ledgers, this view is radically erroneous as to industrial accounting, the ultimate purpose of which is to determine correctly the cost of products, and to furnish information which will guide the management definitely and reliably in determining where economies should be sought and how to obtain them. Taken in this sense industrial accounting is a science, and a somewhat complex one—a science which has enlisted in recent years the time and thought of brilliant and able men, who have brought it to a high stage of development and whose work to some extent is accessible for the guidance of others. Unfortunately, this broad field of work, although already highly developed and possessing a vast fund of accumulated experience, is as yet almost without any literature or other available record of its achievements, so that the work of industrial accounting which is required in each industry must be planned, devised and directed by those responsible for it without their being able to avail themselves largely of the similar, and even closely identical, work which may previously have been done by others. No one is competent to do the best work in industrial accounting, especially in planning an organizing it, who has not at least a fair knowledge and understanding

of the technical facts relating to the product concerned and the methods of its production."

In the aim to attain success as an administrator the ambitious engineer may make the mistake of minimizing the importance of attention to details, while the opposite extreme, a devotion of too much time to minutiæ, is also to be avoided.

"The industrial engineer should know every detail of his work. The criticism is sometimes made of a man that he is immersed too much in details, and unfortunately the criticism is often justified. If so justified, however, it is because the man, having a knowledge of the importance of detail, has not also a proper sense of proportion and an equal appreciation of the importance of letting go of detail at the right time. Grasp detail first; shed it afterwards. Master every detail of the work you are responsible for until you understand how it should be done and why. Then shed that detail as fast as you can on your subordinates. Aim always that you shall know at least as much, if not more, about the work than any subordinate; that no one under you shall long or permanently know more that is important about it than you. Get as big men under as you can, but try always to be bigger yourself, and if that implies fresh study and fresh work, do it. Through all your work, and especially if you are called to executive positions, stand squarely for what is right; for integrity, straightforwardness, and honest dealing. You will find temptations enough to do otherwise in any walk of life. Resist them, and you will have not only the satisfaction of doing right but will find also that this pays best. The man who is honest, upright, and straightforward commands the confidence of his employers and wins the respect of his assistants and subordinates. He will lose both in the end if he travels on the other path."

MODEL EXPERIMENTS ON THE LINES OF SHIPS.

TANK EXPERIMENTS ON HOLLOW AND STRAIGHT LINES FOR SHIPS IN SMOOTH AND ROUGH WATER.

R. E. Froude—Institution of Naval Architects.

THE utility of tank experiments in the determination of form and resistance of ships is now so generally accepted that any advances made in the method are of much interest, especially when coming from one so closely identified with the system as Mr. R. E. Froude. The work of the testing tank at Haslar has been of such value in the past that experimental researches there conducted may be accepted as possessing the confidence due to long experience. In a paper presented by Mr. Froude at the recent meeting of the Institution of Naval Architects, some recent experiments are described, these bearing upon the comparative results obtained with models in smooth water and in water in which a wave motion is maintained. Tank experiments are generally conducted in smooth water, although this condition rarely, if ever, exists in actual practice, and experiments to determine the influence of waves, both upon the form of the hull and upon the powering, should be of much practical value. A vessel cannot make the same speed in a rough sea that can be made in smooth water, and it is entirely possible that a form of hull indicated by smooth-water trials may not be the best in the presence of waves.

The wave making apparatus fitted to the tank at Haslar consists of a vertical rocking diaphragm, hinged below the water level at one end of the tank, transversely to the line of the waterway, and oscillated to a uniform stroke and uniform period by a crank motion driven from the workshop shafting. There is a sloping beach at the end of the tank behind the vibrating diaphragm, and upon this incline the waves produced at the rear are received and broken, while the forward waves run the whole length of the waterway, with crest lines square to it. There is thus formed a wave system or swell of a very regular character, against which the model can be towed. The height of waves may be varied by adjusting the radius of the crank, and by means of a specially devised measurer the period and height of waves in any trial

may be closely measured for the record.

"The question of the most advantageous general system or programme of experimenting with models in artificial waves turns on the circumstance (which was to be anticipated from theory, but also appeared very plainly from the first preliminary experiments) that for any given speed of model the augment of resistance due to waves, as well as the behaviour generally, is very sensitive to the period of the wave system. Hence, to obtain a properly instructive measure of the relative qualities of the several forms to be tested, the experiments with each form at each speed must extend over a considerable range of wave period. Accordingly, if we confine ourselves for the moment to considering a single form at a single speed, the programme dictated by these considerations shapes itself as a series of experiments at a series of different periods extending by sufficiently close gradations throughout the range of period within which the resistance augment by waves is important in amount. And each such series needs to be repeated, more or less completely, with as many different crank radii of wave-maker as may prove necessary. Such a large number of experiments being requisite for one speed, it was, of course, out of the question to take many speeds, so as to obtain experimentally for rough water a counterpart of the usual curve of resistance in smooth water. As a fact, in the wave experiments, no more than two different speeds were taken with any model, while the most complete and systematic of the series of experiments made was confined to one speed, three knots less than the intended smooth-water full speed for ship.

"It has been found at various times that models of the size used in these experiments in waves are subject to material resistance variations from time to time, due presumably to slight differences in condition of the surface. Several smooth-water runs were therefore made with each model in connection with each series of experiments in waves, and the resistance so obtained was deducted from that in waves to give the resistance augment due to waves. The final results for the ship are obtained by adding the corresponding effective horse-power augment for the ship to the smooth water effective horse-power determined in the ordinary way from the smooth-water experiments with the models of ordinary size."

Experiments were made upon five forms of hull, the first corresponding to a cruiser form of the usual modern type, while the second and third had the hollow in the fore body and in the after body filled up perfectly straight. The two other models were designed especially for the comparison of hollow and straight lines on even terms.

Naturally the resistance of the straight line models was greater than that of the hull with the hollow lines, a higher powering thus being demanded, but at the same time there was an increase in displacement, permitting the addition of the weight of increased engine power, besides leaving a substantial margin in excess. Thus, for a vessel with hollow lines, there was a displacement of 13,050 tons, which, in the straight line form, was increased to 13,944 tons, a gain of 900 tons, while for the increase in resistance, at a speed of 23 knots the corresponding powers required were 12,000 and 14,000 horse power, a difference of 2,000 horse power, estimated as involving 300 to 400 tons additional weight, the balance being clear gain.

The resistance caused by the action of the waves was practically the same for both models, and this increased resistance was very marked, being in some instances nearly twice as great as the resistance in smooth water, depending upon the magnitude and period of the waves. At the same time the straight-line form appeared to suffer measurably less than the hollow.

The general impression among seamen appears to be in favor of the straight-line model as possessing greater stability, and less speed impairment in rough water than is shown by the hollow-line hulls. The tests with the regular and uniform waves in the tank can hardly be considered as conclusive in comparison with the mixed wave disturbances met at sea, but such trials are certainly of a more practical nature than those made in smooth water. So far as the question of powering is concerned, some information may be obtained as to the necessity of providing increased power to maintain speed in rough weather. It has been maintained that better results

would be obtained by providing a slight increase in beam, sufficient to give the same increase in displacement as is gained by the straight lines, while retaining the hollow-line model, but this appears to be in a manner an evasion of the question, leading simply to a comparison between two different sizes of the same model, without regard to difference in form.

The idea of adding a wave-making attachment to a testing tank for the purpose of studying the behaviour of models under conditions approximating more closely those obtaining at sea, is wholly to be commended, and it is to be hoped that hereafter all important trials will be made both in smooth water and against wave action, as in this only can a sufficient stock of data be obtained to enable reliable conclusions to be drawn.

HIGH-POWER LOCOMOTIVES.

PRACTICAL EXPERIENCE IN THE DESIGN AND OPERATION OF AMERICAN LOCOMOTIVES OF GREAT POWER.

J. E. Muhlfeld—International Railway Congress.

AMONG the subjects discussed at the international railway congress at Washington, one of the most important was that of locomotives and rolling stock, and from this department of the work of the congress we take the report of Mr. J. E. Muhlfeld, upon locomotives of great power as containing many points of interest.

"An American locomotive of great power may be described in a few words as one capable of developing, when properly designed for the speed requirements of passenger and suburban service, at least 20,000 pounds in the cylinders at starting, with provision in suburban service for rapid acceleration and for freight, helper and switching service, at least 40,000 pounds.

"Locomotives are now expected to perform equally well work of the most varied and exacting nature, and the requirements in the way of faster schedules and heavier trains in passenger and freight service have, in connection with lack of substantial maintenance, exceeded the development of the increased power in the machine. Speed limits and train loads are increasing each day and will no doubt continue to do so, as the maximum expansion of car equipment and the length of trains under favorable conditions, have not yet been reached.

"How well the demand can be met in one steam locomotive of the present gage and clearance limits by simplicity in design, flexibility, maximum proportion of adhesive to total weight, good material and construction, pure heated feed water and quickened circulation, compounding, superheating, substantial maintenance, intelligent operation, and other essentials, is a question that must be determined in the very near future; and from this determination will proceed the conclusion as to the proper proportions of each type of locomotive required in the motive power stock for a large, modern railway system.

"Railroads are not operated to save fuel, or to have locomotives that it does not cost much to maintain and run, and while economy must be considered as secondary to getting trains over the road, at the same time, the tractive power required and the limits given within which to acquire this, make it necessary that locomotives be now so constructed and maintained that more work will be derived per unit of fuel; and the result should be economy. Whether the economy will be derived through the use of turbine, internal combustion, pneumatic or electric locomotives, or by a practical development of the steam locomotive from the use of improved boiler, motion gear, superheating, compounding, balancing and other essential features, remains to be determined."

In discussing the requirements of the modern high-power locomotive Mr. Muhlfeld takes up the various parts in succession, and enumerates at length the essentials, as developed by practical experience. We have space here for no more than a close condensation of these points, and can do little more than furnish a guide to the detailed information contained in the original extensive paper.

The boiler must be designed to supply

may be closely measured for the record.

"The question of the most advantageous general system or programme of experimenting with models in artificial waves turns on the circumstance (which was to be anticipated from theory, but also appeared very plainly from the first preliminary experiments) that for any given speed of model the augment of resistance due to waves, as well as the behaviour generally, is very sensitive to the period of the wave system. Hence, to obtain a properly instructive measure of the relative qualities of the several forms to be tested, the experiments with each form at each speed must extend over a considerable range of wave period. Accordingly, if we confine ourselves for the moment to considering a single form at a single speed, the programme dictated by these considerations shapes itself as a series of experiments at a series of different periods extending by sufficiently close gradations throughout the range of period within which the resistance augment by waves is important in amount. And each such series needs to be repeated, more or less completely, with as many different crank radii of wave-maker as may prove necessary. Such a large number of experiments being requisite for one speed, it was, of course, out of the question to take many speeds, so as to obtain experimentally for rough water a counterpart of the usual curve of resistance in smooth water. As a fact, in the wave experiments, no more than two different speeds were taken with any model, while the most complete and systematic of the series of experiments made was confined to one speed, three knots less than the intended smooth-water full speed for ship.

"It has been found at various times that models of the size used in these experiments in waves are subject to material resistance variations from time to time, due presumably to slight differences in condition of the surface. Several smooth-water runs were therefore made with each model in connection with each series of experiments in waves, and the resistance so obtained was deducted from that in waves to give the resistance augment due to waves. The final results for the ship are obtained by adding the corresponding effective horse-power augment for the ship to the smooth water effective horse-power determined in the ordinary way from the smooth-water experiments with the models of ordinary size."

Experiments were made upon five forms of hull, the first corresponding to a cruiser form of the usual modern type, while the second and third had the hollow in the fore body and in the after body filled up perfectly straight. The two other models were designed especially for the comparison of hollow and straight lines on even terms.

Naturally the resistance of the straight line models was greater than that of the hull with the hollow lines, a higher powering thus being demanded, but at the same time there was an increase in displacement, permitting the addition of the weight of increased engine power, besides leaving a substantial margin in excess. Thus, for a vessel with hollow lines, there was a displacement of 13,050 tons, which, in the straight line form, was increased to 13,944 tons, a gain of 900 tons, while for the increase in resistance, at a speed of 23 knots the corresponding powers required were 12,000 and 14,000 horse power, a difference of 2,000 horse power, estimated as involving 300 to 400 tons additional weight, the balance being clear gain.

The resistance caused by the action of the waves was practically the same for both models, and this increased resistance was very marked, being in some instances nearly twice as great as the resistance in smooth water, depending upon the magnitude and period of the waves. At the same time the straight-line form appeared to suffer measurably less than the hollow.

The general impression among seamen appears to be in favor of the straight-line model as possessing greater stability, and less speed impairment in rough water than is shown by the hollow-line hulls. The tests with the regular and uniform waves in the tank can hardly be considered as conclusive in comparison with the mixed wave disturbances met at sea, but such trials are certainly of a more practical nature than those made in smooth water. So far as the question of powering is concerned, some information may be obtained as to the necessity of providing increased power to maintain speed in rough weather. It has been maintained that better results

would be obtained by providing a slight increase in beam, sufficient to give the same increase in displacement as is gained by the straight lines, while retaining the hollow-line model, but this appears to be in a manner an evasion of the question, leading simply to a comparison between two different sizes of the same model, without regard to difference in form.

The idea of adding a wave-making attachment to a testing tank for the purpose of studying the behaviour of models under conditions approximating more closely those obtaining at sea, is wholly to be commended, and it is to be hoped that hereafter all important trials will be made both in smooth water and against wave action, as in this only can a sufficient stock of data be obtained to enable reliable conclusions to be drawn.

HIGH-POWER LOCOMOTIVES.

PRACTICAL EXPERIENCE IN THE DESIGN AND OPERATION OF AMERICAN LOCOMOTIVES OF GREAT POWER.

J. E. Muhlfeld—International Railway Congress.

AMONG the subjects discussed at the international railway congress at Washington, one of the most important was that of locomotives and rolling stock, and from this department of the work of the congress we take the report of Mr. J. E. Muhlfeld, upon locomotives of great power as containing many points of interest.

"An American locomotive of great power may be described in a few words as one capable of developing, when properly designed for the speed requirements of passenger and suburban service, at least 20,000 pounds in the cylinders at starting, with provision in suburban service for rapid acceleration and for freight, helper and switching service, at least 40,000 pounds.

"Locomotives are now expected to perform equally well work of the most varied and exacting nature, and the requirements in the way of faster schedules and heavier trains in passenger and freight service have, in connection with lack of substantial maintenance, exceeded the development of the increased power in the machine. Speed limits and train loads are increasing each day and will no doubt continue to do so, as the maximum expansion of car equipment and the length of trains under favorable conditions, have not yet been reached.

"How well the demand can be met in one steam locomotive of the present gage and clearance limits by simplicity in design, flexibility, maximum proportion of adhesive to total weight, good material and construction, pure heated feed water and quickened circulation, compounding, superheating, substantial maintenance, intelligent operation, and other essentials, is a question that must be determined in the very near future; and from this determination will proceed the conclusion as to the proper proportions of each type of locomotive required in the motive power stock for a large, modern railway system.

"Railroads are not operated to save fuel, or to have locomotives that it does not cost much to maintain and run, and while economy must be considered as secondary to getting trains over the road, at the same time, the tractive power required and the limits given within which to acquire this, make it necessary that locomotives be now so constructed and maintained that more work will be derived per unit of fuel; and the result should be economy. Whether the economy will be derived through the use of turbine, internal combustion, pneumatic or electric locomotives, or by a practical development of the steam locomotive from the use of improved boiler, motion gear, superheating, compounding, balancing and other essential features, remains to be determined."

In discussing the requirements of the modern high-power locomotive Mr. Muhlfeld takes up the various parts in succession, and enumerates at length the essentials, as developed by practical experience. We have space here for no more than a close condensation of these points, and can do little more than furnish a guide to the detailed information contained in the original extensive paper.

The boiler must be designed to supply

steam, not only for motive power, but for a host of auxiliaries, and it should be simple in design, using a large factor of safety and a great excess of strength over any legitimate stress. The principal features covered by the detailed specifications for the boiler are those providing for active circulation of the water, freedom from expansion and contraction stresses, and access for cleaning a repair. The proportions of heating and grate surface are determined by the service, pressures of 200 to 250 pounds being considered, all these requirements demanding the best of material and the very highest grade of workmanship.

An important element in boiler performance is the purity of the feed water and the method by which it is introduced. The water for heavy boilers in heavy service should be purified, and it should also be heated, either from the exhaust steam or by the exhaust gases. Apart from the economy effected by heating the feed the strains on the boiler are minimized, and much of the injury due to temperature differences prevented. Superheating is distinctly recommended, both for simple and for compound engines.

The high powering of locomotives is responsible for a marked increase in stresses on cylinders, pistons, and frames, especially in the case of engines of moderate speed, where the increase in power is due to larger cylinders and higher pressures. The heavier parts produce increased inertia stresses, and the frames should be well stayed and braced to the cylinders, boiler and each other. For the same reasons increased dimensions should be given to the pistons, and in general the actual stresses on the working parts should be considered rather than empirical proportions deduced from conditions of lighter service.

The increased dimensions required for the link motion and valve gear parts, as well as the desirability of placing the valve motion outside of the frames is causing attention to be given to the Walschaert motion. This motion, which on the Continent has become almost the only one employed, has many advantages, and there is every probability that it will come into as general use in America as in Europe. Its advantages were pointed out many years ago by Auchincloss, but until recently it has been almost entirely ignored in the United States.

Mr. Muhlfeld accepts the fact that compound locomotives are to be advocated when the cost of fuel is high and the gradient conditions favorable, but when fuel is cheap he considers the single-expansion type the most economical, providing sufficient steaming capacity can be obtained from the permissible weight of the locomotive.

Locomotives of great tractive power are not generally wrong in principle, but their growth has been too rapid for strict adherence to practice applicable to lighter equipment, and in the future development full advantage should be taken of past and present experience by giving more thorough and practical attention to all details entering into the new construction.

The general conclusions of the report may be taken as expressing the present state of practice with regard to high-powered locomotives, and as given below they form an excellent summary of an important paper.

"Locomotives of great power, within the present gauge, clearance and weight limits, may be designed and constructed to remain modern for several years and produce a higher average speed and tractive power with less cost for locomotive expenses per unit of power developed, than that given by locomotives of large capacity in use to-day or from the previous lighter equipment.

"The efficiency and economy predicted and anticipated from the use of locomotives of great power have not been attained. Their development has been too rapid on the basis of the theoretical calculations which did not include the necessary factors for practical results, and also owing to the disregard of simplicity in design, substantial maintenance and speed as elements of economy.

"Locomotives of comparatively recent construction have been built without proper consideration for the use of railroad standard designs, specifications, practices and processes which continued and practical experience may have determined to be more suitable and interchangeable than the standards of locomotive builders.

"The present ineffective load should be reduced by the use of design and material

which will combine the least weight and greatest desired strength.

"The elimination of those individual preferences, patented devices, fads and frills which have no real value, by the use of simple, practical design and construction, will produce more satisfactory general results.

"The mechanical department supervision has often been curtailed when expansion of organization and direct, mechanical control should have been given to insure the desired performance. Changes in organization and methods have frequently been effected in preference to conservative management, with instruction, education and substantial recognition for the deserving rank and file.

"The locomotive maintenance and dispatch facilities have not always been developed to meet the proportionate increase in the locomotive dimensions, capacity and requirements, while slow line movement has made it necessary to increase average mileage by reducing terminal mechanical delay during a period when more opportunity for maintenance and handling has been essential.

"The tonnage hauled per train has frequently precluded the making of an average speed between initial and destination terminals that would be productive of efficiency and economy in locomotive operation.

"Decreased efficiency has resulted from the irregular transferring and crewing of locomotives for long runs. The regular assignment of crews to locomotives and of suitable locomotives to shorter runs on regular districts, should accomplish the best results.

"Provision for the cleanliness and care of employees and equipment on the line and at terminals, should receive more consideration.

"Personal supervision and investigation should govern in the construction and operation of locomotives of great power, whilst statistical information and correspondence should be limited and used with caution."

FACTORS OF SAFETY.

THE INFLUENCE OF MARGINS AND FACTORS OF SAFETY UPON THE DESIGN AND PROPORTIONS OF MACHINERY.

A. E. Seaton—Institution of Naval Architects.

IF it were possible to obtain full and complete knowledge of the resistances of materials of construction, and also to discover the nature and magnitude of all the stresses imposed upon the various members of a given structure the problems of proportion and distribution of material might be made with a precision which would leave nothing to be desired. As a matter of fact the engineer has to deal with materials of varying strengths, concerning which his information is necessarily limited, and at the same time his knowledge of the stresses, working and accidental, is far from being complete. Under these circumstances it is necessary to supplement the dimensions obtained by computation by a margin, giving an excess of material to provide for the unforeseen forces to which his work may be subjected. This margin, commonly known by the title "factor of safety" has also been termed the "factor of ignorance," not as implying a lack of knowledge, but as providing for the unexpected, which usually happens.

Among the papers presented at the recent meeting of the Institution of Naval Architects was one by the well-known marine engineer Mr. A. E. Seaton, dealing with this subject of margins and factors of safety, and showing how such factors should be rationally used. Mr. Seaton discusses principally the design of marine machinery, but the principles and methods are applicable equally well to machine design in general.

"Every structure and machine must be so designed that, when properly constructed, it is capable of safely carrying the load or developing the power for which it was intended for a considerable period; some, in fact, must do so for an indefinitely long time. At the same time, such structures and machines are, as a rule, for good and sufficient reasons, not made stronger or heavier than necessary.

"In recent years, in fact, a demand has arisen for something that shall be as light as possible consistent with the necessary strength; in such cases, however, endurance is not generally of prime or even great consequence. Notwithstanding this, every designer of such things, as, indeed, every business man, likes to have a margin on which to 'come and go,' as well as one which shall not be trenched on under normal conditions. Most rules and formulæ contain, either latent or apparent, some provision for such margins and one hears, both in the lecture theatre and drawing office, much talk of 'margins of safety' and 'factors of safety;' but it is doubtful if these things are as clearly appreciated there, or elsewhere, as is desirable in their full meaning and effects.

"One has only to read an ordinary specification of a ship or engine to perceive how nebulous appears to be the knowledge of their authors of the dangers for which factors and margins of safety are supposed to be the insurance; it will also appear that the cure for these ills, whose cause is so often not understood fully, are applied as promiscuously and with the same faith as are patent medicines for bodily ailments. Further, some of them, too, have the old analogy, in their effects, to certain drugs, inasmuch as they produce the disease they are supposed to cure.

"The component parts of structures and machines are subject to be stressed in either one or more of the following ways—viz:—

"1. By a steady and constant pull, so that the metal is in tension, or by a steady and constant pressure, so that the metal is in compression.

"2. By a pull or pressure repeatedly but gently applied and removed, so as to vary in intensity from 0 to a maximum, and the reverse.

"3. By the repeated sudden application of the full load, and its sudden removal at intervals, so that the material is suddenly and intermittently subject to tension or compression.

"4. By the repeated gradual application, gradual withdrawal and reversal of the load, so that the material is alternately in tension and compresion.

"5. By the repeated sudden application and reversal of the load, so that the material is alternately in tension and compression, the changes being sudden and violent from plus to minus."

A mere examination of the variety of stresses enumerated above will show that the margin of safety need not be the same for all of them. A member under constant and steady tension or compression does not require so great a safety factor as one subjected to sudden and varying stresses, and the real occasion of a factor of safety in such a case is to make provision for variations in the strength of the material.

"It is admitted that no metal under load should be stressed beyond its elastic limit or yield-point; it used to be considered that, if the load never stressed it to the limit of elasticity, the metal could not give way, and should last for ever. We know now that, under certain circumstances, metals will give way when apparently stressed much below that point; but we also know that to bring on destruction in that way the load must be intermittent; further, we know that if the stress is an alternating one, its magnitude, to produce fracture, may be still less than if intermittent.

"Modern research, especially that of Professor Arnold, has shown that time also enters very largely into the account when dealing with dynamic forces; that the quicker the application of the load the fewer are the repetitions necessary to ensure fracture; or, the oftener per minute are the repetitions of load, the smaller that load need be to produce fracture. Now, although we know, and have known, most of these things for many years, do we always act upon this knowledge when determining the so-called margins of safety? Are engineers always consistent in fixing the magnitude of such allowances as they make? Let us see what are really the dangers for which provision has to be made. The wrought materials used nowadays can generally be got out of fairly uniform quality, and we have the means in the tensile and drop-testing machines of ascertaining that quality, and their general suitability for the purpose for which they are wanted. Any danger due to faulty material should therefore be slight, and little or no margin is required for insurance.

"The formulæ and rules on which a de-

sign is evolved may be, and sometimes are, subject to doubt; for example, those used for giving the stress on a shaft due to torsion really only give the shear on the outer envelope, or skin, of the shaft, aud without allowing for the fact that that skin is firmly attached to, and therefore supported by, the next layer of metal.

"Such also is the case when calculating the stress on a beam subject to cross-bending. But in the case of a rod suspending a weight, or in that of a short stanchion supporting a load, there can be no scepticism.

"With the shaft subject to torsion, it is difficult to determine what is the greatest nominal stress that may be put on the outer layer, so that the shaft may run in safety indefinitely. It must, of course, be such that at any point it is really below the yield-point; but how much can only be determined positively by experiment. If the shaft is subject to a steady torque, or one whose torsional variations are slight, probably the nominal stress may safely be as high as 75 per cent. of the yield-point while, if the variations are great and violent, it might not be safe with only 40 per cent. Again, if the shaft has on it a fly-wheel or a screw propeller, so that there are rapidly changing alternating stresses due to the bending moment as well as shearing forces due to torsion, perhaps 30 per cent. would not be too little to reckon on."

Mr. Seaton refers to the anomalies in the requirements of the British Board of Trade, citing as examples the fact that bridges, subjected to sudden intermittent loads, are permitted a lower factor of safety than marine boilers, in which the load is gradually applied and maintained with uniformity for long periods; also the fact that a lower margin is required for locomotive boilers than for marine boilers.

The insistence of too high a factor of safety is a mistake which may work distinct disadvantages, and the proper and scientific method is to make the margin proportional to the nature of the stresses, giving the greater proportion to structures and members exposed to sudden and irregular action, and thus avoiding excessive weights and maintaining a proper balance of strength in all parts of the structure.

"In order that a steamship may have a margin of safety to ensure her doing the intended voyage at the scheduled speed, most shipowners insist on having the trial-trip speed considerably in excess of it; the builders accept these conditions, and, knowing they are legally liable for heavy penalties for non-performance of the speed, even when no penalty is named, usually design the ship and provide engines and boilers for a still higher speed, so that they may have in their turn a margin of safety.

"Hence it comes to pass that a ship whose service speed is to be 17½ knots not uncommonly does 19½ knots on trial under service conditions, and that not on a series of runs on the measured mile, but on a long course, often of 100 miles. The effect of this kind of margin is most serious both on the design of the machinery and the ship. The latter must be formed with finer lines than there is really occasion for, with a corresponding loss of displacement; the machinery is much heavier and bulkier than necessary, thereby taking away from the carrying capacity, and often also from passenger space as well. The engine cylinders have such clearances as to reduce the steam efficiency at the service speeds; and the screws necessary for the high trial speed are not of the best proportions for the service speeds.

"I think that neither shipowners nor builders always fully realise the evils and cost of this pernicious way of insuring satisfactory performance. If the speed on service is to be 17½ knots, why not design the ship for it? If it be urged that, to make up time lost by fogs or bad weather there must be a reserve of some kind, this can be done by increasing the power and obtaining the higher speed with a slight decrease in the efficiency. It is surely better to have the lower efficiency during these occasional times than during normal conditions."

It will be seen that when the factor of safety is considered in a rational manner, as indicated by Mr. Seaton, it is no longer a factor of ignorance, but a scientific provision for emergencies, which, if not within the range of precise computation, may at least be provided for in some sort of fair proportion.

ENGINEERING LABORATORY METHODS.

THE FUNCTION OF LABORATORY INSTRUCTION IN THE CURRICULUM OF THE ENGINEERING SCHOOL.

Dr. Charles E. Lucke—American Society of Mechanical Engineers.

AMONG the papers presented at the recent convention of the American Society of Mechanical Engineers that of Dr. Charles E. Lucke upon the use of the engineering laboratory brought out an interested discussion from engineers engaged in the problems of technical education. It was the general opinion of eminent educators who visited the United States during the past year that many of the mechanical laboratories were remarkably complete and well equipped, but the opinion was also expressed that many of these fine work rooms suffered from an over-provision of appliances and an under-provision of teachers and well prepared students. Dr. Lucke takes up these and similar criticisms, discussing the various methods by which the mechanical laboratory may be employed.

"The object of all professional engineering schools is to send away thinking men with the equipment to become good engineers. A good engineer is a man who can do things in a certain field of labor rather than a man who knows a large number of facts in that same field, but is unable to use them. The technical school *can* teach students facts, and *may* train men to do and to think, but may fail utterly to do so. Much depends on the student's physical endowment, more depends on the methods of instruction, but most on the characteristics of the instructor and his individuality. This applies to such parts of the course of instruction as are dependent on the laboratory apparatus. If, by the use of apparatus, the student can acquire more than without it well and good, but the use of that apparatus will be better justified if, in addition, the student can be made to think more clearly, more boldly, more originally than without it, and finally when through the use of that apparatus he can be taught to do things, then not only is the use of apparatus justified, but it must be regarded as indispensable be the cost what it may. However, it is not sufficient that the above results are merely possible; it is even more necessary that the results be actually attained. If a result is possible, it can always be attained by proper methods."

In many cases the attempt has been made to impart instruction according to methods previously tabulated and codified, so that the student has little more to do than the filling out of blanks in printed report blanks. Such methods are undesirable in that they leave little or no thinking to be done by the student and may even result in giving him incorrect ideas. Dr. Lucke shows the defects of such routine methods, and prefers what he calls the method of successive problem solution, the student being given graded investigations to work out for himself under the general supervision of the instructor.

"This research, or successive problem solution, method of conducting laboratory work with apparatus of the best seems to promise the student training of the kind that counts for success as an engineer whose whole life is one long succession of meeting and solving problems. The method may differ from what has been defined as the upper limit of methods—pure research—in giving to the student some real help, but not enough to deprive him of the necessity for good vigorous thinking with the pleasure and sense of power which results from success attained after effort. The best form for this help to take is the assignment of a definite piece of apparatus for the solution of every problem and the fitting of that apparatus with the necessary instruments, the manipulation of which may be explained, but no more."

A general account of the methods employed at Columbia University shows that this method is entirely applicable for use in connection with the other departments of instruction to be given in the technical school, and that it succeeds in awakening self-confidence and ambition in the student in a very encouraging manner.

"The working out and interpretation of results calls again for application of all the principles known and comparison with re-

sults of other experiments, and might well be the daily experience of any of our best engineers, while the clear writing of a concise report on the whole process is likewise no more or less than common engineering practice. After the solution of some fifty or sixty such problems the student is ready for his thesis problem, which now has no element of mystery, but is a simple, straightforward process, different in detail from anything done, yet no more different than the regular problems were from each other, and again duplicating as nearly as possible conditions to be met in future professional life. In this work, however, the detail of apparatus is a new element and practically the only one, but the thesis is usually more difficult of solution, and calls for all the preparation, skill and power of organization available.

"To sum up the situation discussed, there are different methods of executing laboratory instruction in engineering schools, and these range from the complete written-instruction method, which might be carried out by any intelligent man, to the pure research method, in which a problem is assigned and no assistance given for solution except facilities of laboratory and library. Equipment for such laboratory instruction is also quite various in kind and excellence, but on the average represents large outlays of money for installation and maintenance.

"It is difficult to see how all the schools with variety of apparatus and method of using the same can accomplish the same ends. It does seem, however, that the aim of the instruction or the object to be attained in the student, may justify both method and apparatus, and that old, worn or small pieces will suffice when the aim is to teach the commercial tests, in which case also the complete printed report form is satisfactory. When, however, it is the aim of the instruction to make useful engineers, in the highest sense, by sending out bold and clear-thinking men, well equipped with the fundamental principles and their application, then the modified research method in some form is absolutely necessary. In this case the great range of problems and variety of the scientific foundation material make the most complete laboratory, none too good nor need any part of it lie idle for want of usefulness."

THE PRODUCTION OF POWER GAS.

THE GASIFICATION OF FUELS IN PRODUCERS, WITH ESPECIAL REFERENCE TO THE OPERATION OF INTERNAL-COMBUSTION MOTORS.

Karl Kutzbach—Verein Deutscher Ingenieure.

WITH the increasing attention which is being given to the use of internal-combustion motors there has arisen a necessity for a more scientific treatment of the gas producer, and upon the design of this portion of a gas-power plant much of the success of its performance depends. In a paper presented before the *Verein Deutscher Ingenieure* by Herr Karl Kutzbach, and published in the *Zeitschrift* of the society the subject of gas producers for internal combustion engines is considered very fully and some abstract is here given.

Doubtless the first producers of fuel gas were the blast furnaces used in the smelting of iron, and attempts to use this gas were made as early as 1814 by Aubetot, and more extensively in 1837 by Faber du Faur at Wasseralfingen, but the first systematic production of fuel gas in an independent producer seems to be due to Ebelmen, in France, about 1841. The apparatus of Ebelmen appears to have been very complete, including the preheating of the air, forced blast, and the introduction of superheated steam. By the use of a slag to act as a flux the noncombustible portion of the fuel was fused and drawn off in liquid form, the fuel being introduced by means of a funnel and cone. The gas made in these producers was used in puddling furnaces, and it was not until the introduction of the gas engine that the modern producer of Dowson was made, his patents being dated 1878 and 1883.

The Dowson system includes a producer, a steam boiler, an injector for delivering the air and steam into the generator, and a scrubber, purifier, and holder for the re-

sultant gas. The Dowson system is excellent where the plant is of sufficient importance to warrant the introduction of a works of magnitude, and it remained for the development of the suction gas producer to adapt the method to gas-power plants of all sizes.

Herr Kutzbach lays down the following principles which must be kept in mind in designing a successful gas producer system:

It must utilize the combustible to the best possible advantage, avoiding all loss of heat and producing a gas best adapted for use in the engine.

It must be entirely free from danger when in operation.

The costs of installation and of operation must be reduced to the lowest possible figure.

So far as the loss of heat is concerned, it is impracticable to carry the heat for any distance with the gas, and hence the heat of gasification of the fuel should be used in immediate connection with the producer, as in the production of the vapor and in the preheating of the air. Since the steam delivered into the condenser is decomposed by the incandescent fuel a portion of the sensible heat is utilized in this way, while the superheating of the steam is also effected by the heat of the combustion in the producer.

Herr Kutzbach examines in detail the thermochemistry of the combustion which occurs in the gas producer, taking up the combinations of the oxygen of the air with the carbon of the fuel, and also the decomposition of the vapor of water, with the liberation of the hydrogen and the combination of the oxygen with the carbon. In addition to the chemical equations, the operations are shown graphically, employing the isometric diagram, and thus enabling relations of three variables to be plotted simultaneously.

The combustion in a gas producer takes place very differently from that occurring on a boiler grate, and the temperature is far from uniform in different parts of the apparatus. The temperature increases upwards from the grate until all the oxygen is consumed, after which it diminishes. The formation of carbon monoxide or dioxide depends upon the temperature at each point. The transformation of the carbon dioxide already formed into monoxide occurs in the heated layers and the inverse change in the cooler portions, these going on simultaneously. The gas is thus a mixture of the two formations, changing at different points according to the temperatures. In producers operating at a high temperature the proportion of carbon dioxide is small, running as low as 1 to 2 per cent.

In considering the operation of the gas producer it is necessary to decide upon the most desirable mixture for use in an engine. The combustible elements are the carbon monoxide and the hydrogen, and the relative proportions are variable. The hydrogen has a much lower ignition temperature than the carbon monoxide, and also a much higher rate of combustion. It is also diffused more rapidly into the air, and it requires a greater excess of air for its combustion than the monoxide. In view of these properties it is the proportion of hydrogen which must be considered. If there is too much, the action of the engine will be effected, either by pre-ignition during the compression stroke, or by too violent explosions. If there is too little hydrogen present the gas will be sluggish in igniting. In practice it is found that there should be from 10 to 15 per cent. of hydrogen in the gas, corresponding to about 5 per cent. in the mixture of gas and air delivered to the engine cylinder.

So far as the practical proportions of producers are concerned, these have an important influence upon the performance. The combustion taking place in the interior of the mass of the fuel, the dimensions depend somewhat upon the sizes of the pieces, or rather upon the active surface exposed by the lumps. For convenience in operation it is desirable that a producer should hold enough fuel to be able to run for at least five hours without charging. If the producer is not well proportioned there will be unburned air passing through to the upper portion, and some of the carbon monoxide will be converted into dioxide. The area of the grate should be materially smaller than is indicated for a boiler furnace, this because of the smaller proportion of air required. In ordinary instances

the grate may be about one-half the area required for a boiler furnace consuming an equal quantity of coal, and if the draft is assisted the grate area may be made even smaller. The amount of air required is only about one-third that demanded for the complete combustion of the coal in a boiler furnace, and the air spaces in the grate may be proportioned accordingly.

The most serious practical difficulty in the operation of gas producers is found in the formation of slag and cinder. The cinder gathers in the lower portions of the producer, but when it is of a partially fusible nature it forms masses of clinker in the shaft of the producer, requiring to be broken up by poking or barring through holes arranged for the purpose.

Various methods have been devised for removing the cinder. In the blast furnace the flux renders the slag fluid, and it can be tapped off in the liquid form, and this method was also adopted by Ebelmen, as noted above. Another method is that of periodically cooling the producer by the admission of an excess of steam, this causing the cinder to break up more readily. The reversed draft producer is also used to avoid trouble with cinder, the slag being readily removed from the bottom.

So far as the second condition, that of security, is concerned, it is included in ordinary carefulness. The charging should be regularly attended to, and a constant proportion of air and steam supplied. Herr Kutzbach suggests the great desirability of some kind of a device which should indicate continuously the composition of the gas as it is produced, this serving a similar purpose to the pressure and water gauges on a steam boiler. Such an indicator would be of especial value in large plants where the opportunity for variation is greater than in a small installation which may be so adjusted as to be practically automatic.

The economy of gas power installations is fully understood. A gas producer has an efficiency of at least 75 per cent., equal to that of a steam boiler. The efficiency of the gas engine, however, is 25 to 30 per cent., as against 10 to 15 per cent. for the steam engine, the resultant total economy being 40 to 70 per cent. in favor of the gas engine plant. Especially is the advantage seen in the case of small installations, since the small gas engine is as efficient as the large one, while the small steam engine has a far lower efficiency than the above figures.

THE STRENGTH OF METALS AT LOW TEMPERATURES.

EXPERIMENTS RELATING TO THE EFFECT ON MECHANICAL AND OTHER PROPERTIES OF IRON AND ITS ALLOYS PRODUCED BY LIQUID AIR TEMPERATURES.

R. A. Hadfield—Iron and Steel Institute.

IT has long been known that the properties of metals are affected by temperature changes, and many a fracture of a rail or other member in cold weather has been attributed to brittleness caused by the cold. There has been little authoritative information upon the question, however, and hence the paper of Mr. R. A. Hadfield, presented at the recent meeting of the Iron and Steel Institute, is of especial interest.

Mr. Hadfield set out to determine the effects of very low temperatures upon the strength of iron and its alloys, and for this purpose he enlisted the services of Professor Dewar, whose work in the liquefaction of gases and the attainment of low temperatures at the Royal Institution has placed him in the front rank of experimental physicists. A number of experiments had already been made at the Royal Institution upon the action of liquid air upon the properties of various metals, and hence it was decided that similar researches upon the iron alloys would be of practical importance.

Mr. Hadfield prepared a large number of specimens in duplicate, one set of these being delivered to Professor Dewar for test at the temperature of liquid air, while the other sets were tested at ordinary temperature, the work being thus performed upon a scale and according to methods giving results which are entirely comparable.

"For the purpose of the experiments, the irons were taken in the form of forged bars, and the iron alloys in the form of cast

ingots 2½ in. square. These were carefully heated to the required forging and rolling temperatures, which necessarily varied according to the nature of the material, and were reduced to bars or rods of about ¼ in. diameter. From these bars or rods finished test pieces were prepared in the lathe.

"Quite a number of the alloys were too hard to be machined; in these cases the bars were forged roughly to shape, and then finally finished by grinding to the same dimensions as the machined bars.

"The mechanical tests consisted in determining the tenacity or breaking strength of the specimens, or, more correctly, ascertaining the maximum tensile stress which the specimens stood before breaking; also at the same time obtaining their ductility, as shown by the elongation of each specimen measured over a length of 2 in. The gripping arrangement, to the full depth of the test bar and holder, was immersed in the liquid air.

"The test pieces were allowed to remain several minutes in the liquid air, until all 'boiling effects' ceased. This insured each bar being reduced to the liquid air temperature, that is—182 degrees C. The elongation was taken afterwards, that is, at ordinary temperatures, by clamping the bars together, and noticing the total elongation produced by the tensile stress."

Among the test specimens there was included some of Swedish charcoal iron procured with especial care by Mr. Hadfield to represent as nearly as possible pure iron, these pieces containing 99.82 per cent. of pure iron, with 0.045 carbon, 0.07 silicon, 0.005 sulphur, 0.004 phosphorus, and a trace of manganese. This material, after careful annealing, gave a tensile strength of 20 tons per square inch, with an elongation of 20 per cent. After quenching in liquid air, at a temperature of—182° C., the tenacity rose to 38 tons, and the elongation became zero. A similar specimen immersed in liquid air and allowed to return to the ordinary temperature, 15° C., gave practically the same results as the original, showing that the effect was actually due to the temperature.

The tests with alloys of iron and one, two, or three predominant elements are detailed at length in the original paper of Mr. Hadfield, to which the reader is referred for details, but attention must be called to the fact that the presence of nickel causes the ductility to be retained to a greater or less degree. Thus the presence of about 2 per cent. of nickel causes the elongation of 20 per cent. at ordinary temperatures to be reduced only to about 12 per cent. at the temperature of liquid air, while with 24 per cent. of nickel the elongation of 12 per cent. falls only to 10 per cent. at the low temperature. Most remarkable of all, however, is a specimen containing 1.18 carbon, 6.05 manganese, and 24.30 per cent. of nickel, this showing an actual rise in ductility by the cooling treatment. When this alloy is immersed in liquid air the tenacity rises from 51 to 84 tons per square inch and the ductility from 60 to 67 per cent.

"It is very clear that as regards iron and iron alloys, with, however, certain exceptions, the effect of low temperatures is to increase in a remarkable degree resistance to tensile stress, ordinarily known as the breaking load or tenacity, and to reduce ductility, as measured by elongation, from the highest point, for example, in mild steel 30 to 40 per cent., to practically nil. The changes take place to the same extent, and this is very curious, in the softest wrought iron as represented by the specimens Swedish charcoal iron, and also English wrought iron, and in carbon steel samples from 0.10 per cent., or 0.20 per cent. to the high percentages such as 1.25 per cent., or 1.50 per cent. Thus, the absence or presence of carbon in ordinary carbon steel in which other special elements are not present seems to have but little influence. That there is no error in this statement is proved, independently of the tensile tests, by the fact that several bars of the Swedish charcoal iron and mild steel specimens were submitted to the low temperature test, and tested by hand hammer immediately after immersion. In all cases they exhibited great brittleness, breaking off instantly upon being struck with the hammer; there was an entire absence of ductility.

"Further confirmation is obtained by the Brinell hardness ball test, a method of testing explained elsewhere. Under this test the Swedish charcoal iron specimen at normal temperature had a hardness number of 90, whereas when tested at about—182 degrees C. this increased to no less than 266,

or about equal to the hardness of 0.80 per cent. carbon steel at normal temperature. This almost seems incredible when it is remembered that the Swedish charcoal iron shows by analysis 99.82 per cent. of iron, and normally has only 20 to 22 tons tenacity with 25.30 per cent. elongation.

"The importance of the discovery of the toughening effect of nickel upon iron at low temperatures will be seen when it is understood that whilst it has been well known that nickel in certain percentages produced important improvements in the qualities and properties of iron and steel alloys, no microscopical or chemical research work has yet proved why this came about. To the author it seems clear that these experiments go a long way towards offering a satisfactory explanation.

"It will be seen that the purest iron, as represented by the Swedish charcoal iron, containing 99.82 per cent. iron and of specially high quality and purity, becomes brittle to an extraordinary degree under the influence of the low temperature—182 degrees C., whereas nickel itself tested at the same low temperature has improved rather than deteriorated, not only in tenacity, which iron also does, but in ductility, in which latter quality iron entirely breaks down. If nickel, therefore, is present in an iron alloy containing but little carbon or comparatively low in that element, it acts as a preventive of brittleness, or is a very considerable modifier of that objectionable quality.

"It may be interesting to state that at ordinary temperatures the toughness or ductility of nickel is no greater than that of iron. For example, in comparative tensile tests, made by the writer, of nickel and pure iron, the ductility of iron was greater. The reduction of area in the material generally shows its condition as regards ductility; in the specimens in question the reduction of area in the tensile test bars was nearly 20 per cent. greater for iron in both the author's Swedish charcoal iron and Arnold's pure iron than in the nickel specimen.

"Iron to a more or less degree, at any rate in manufacturing operations, always seems to be endeavouring to wander out of the 'paths' of ductility and toughness—it is constantly endeavouring to become brittle. It will often assume its apparently brittle nature on the slightest provocation, and the metallurgist by his arts is always trying to correct this tendency. As with humanity, there seems to be a law of tendencies, and iron by heredity is constitutionally weak. It would appear, therefore, that iron, a cheap and convenient metal itself, must be permeated by some element that will mask or modify its properties. Until comparatively recently carbon was the only element known to modify the properties of iron; but, as will be seen in this research, this element, where great toughness is required, only helps to make matters worse.

"Fortunately for iron, however, its close companion, nickel, singularly enough in the same group, comes along and acts as a friend in keeping it—iron—up to the mark and preventing it from wandering out of the narrow road of metallurgical rectitude, that is, of toughness or ductility. Exactly why this should be so cannot easily be explained, but this is the fact. Possibly some interpenetration of the atomic mass causes a change which cannot as yet be deduced by any known chemical investigations. Iron, too, is a very crystalline metal, whereas nickel appears to be much more amorphous; it is possible, therefore, that nickel tends to prevent iron crystallising in this manner, or prevents it cooling in such large or dangerous type of crystals. This action of nickel is simply marvellous in certain of the alloy specimens, especially in an alloy of iron, carbon 1.18 per cent., nickel 24.30 per cent., and manganese 6.05 per cent. Here the ductility is extraordinary at not only ordinary but low temperatures, probably the highest known for any iron alloy, and certainly for an alloy having such tenacity as 84 tons per square inch. There is still present in this alloy 68 per cent. of iron, yet the tendency of the latter metal to wander into the paths of brittleness is not only entirely checked at the liquid air temperature—and this brittleness, as shown so clearly in this research, occurs to an extraordinary extent in pure iron cooled to—182 degrees C.—but the elongation or ductility already so great is considerably increased, namely, from 60 per cent. to 67½ per cent. There is also an increase of tenacity in both cases, namely, a rise of from 10 to 38 per cent. Thus the

nickel present—as these results cannot apparently be ascribed to any other cause—enables the bar under this high tension and at—182 deegrees C. to remain far more ductile than the very best of ductile iron of one-third the tenacity. Although the action of nickel has been specially referred to, it must not be overlooked that in this alloy there is also present 6 per cent. of manganese, which in its ordinary combination with iron, that is, with no nickel present, would confer intense brittleness upon the iron and render it more brittle than if not present. This treble combination of nickel-manganese with iron appears to reverse all the known laws of iron alloys."

THE VALUE OF ALCOHOL FUEL.

A COMPARATIVE STUDY OF THE TRIALS AT THE EXHIBITION OF ALCOHOL MOTORS AT VIENNA.

Lucien Périssé—Société des Ingénieurs Civils de France.

THE question of the availability of alcohol as a fuel for internal-combustion motors, replacing gasoline, benzine, and the other light petroleum products, has been discussed already in these pages, but the subject is too important to be allowed to rest, especially in view of the fact that proper legislation has not yet been effected in countries where it might have been supposed that the industrial and commercial value of the material would have been promptly appreciated.

During the exposition held last year in Vienna the fuel value of denaturized alcohol was very fully tested by conducting a number of trials of various forms of internal-combustion motors with alcohol fuel, and a résumé of these tests has been presented in the form of a paper before the *Société des Ingénieurs Civils de France* by M. Lucien Périssé, from which communication we make some abstract and review. M. Périssé himself had charge of the testing station as well as of the installation of the French exhibits, and hence his opportunities of securing information and data were unsurpassed, while his general familiarity with the subject of internal-combustion motors renders him especially competent to present a technical discussion of this important question.

The motors exhibited represented a number of well-known makes, but the question of the machines was a secondary matter, interest being directed rather to the different varieties of denaturized alcohols, their effectiveness as fuels, and their influence upon the machines in which they may be employed.

The principal tests were made upon a special motor of the Gobron-Brillié type, this being a 10 horse power automobile engine, mounted as a stationary motor for the purpose of the tests. By making the tests of the various fuels upon the same machine the only variable element was the fuel, and comparable results were directly obtainable. In making the trials the performance of the engine was observed by the use of the Mathot continuous indicator, this giving a record of the successive explosions in the cylinders, while the independent indicator diagrams were taken with a separate Garnier indicator. These diagrams were not intended for the determination of the power developed, but only to show the behaviour of the fuel as regards regularity of ignition, completeness of combustion, and general action in the cylinder. The power was measured by the windmill dynamometer of the late Colonel Renard, the instrument used having been especially calibrated by the inventor before and after the tests. This ingenious apparatus has already been mentioned in these columns, but it may be briefly described as consisting of a pair of arms attached to the shaft of the engine, each arm carrying a square vane offering sufficient surface to the air to create enough resistance to absorb the entire power of the motor. The vanes may be adjusted to different distances from the axis, each position offering a resistance requiring a definite power to maintain a given rotative speed. The power required to drive the arms at various speeds is readily determined by running the apparatus with an electric motor, and measuring the electrical energy, and a diagram can be constructed

showing exactly the effective resistance of the apparatus at any speed for any position of the vanes. The device has the advantage over the Prony brake of operating well at high speeds, and of requiring no cooling other than that which is effected by the air itself. The only observation required is that of the rotative speed, readily secured by a mechanical counter, the power being subsequently obtained by a simple inspection of the special diagram prepared from the calibration tests of the apparatus. In the Vienna trials the speeds were taken by a Darras chronograph, checked by a Garnier chronometer reading to one-fifth of a second. Tests were made upon other machines, and comparative results obtained, but especial interest attaches to the fuel tests with various kinds of denaturized alcohols.

The most important part of the paper of M. Périssé relates to the different methods of denaturizing alcohol in various countries.

In order that alcohol may be freed from taxation as an intoxicating beverage it is necessary that it shall be so treated as to render it impossible for drinking. The substances added to produce this result should render the alcohol still more effective as a fuel, and should not cause it to be injurious or corrosive to the working parts of the engine. Furthermore, the denaturant must have practically the same boiling point as the alcohol itself, otherwise the mixture could readily be separated by distillation, and pure alcohol obtained for drinking purposes.

The composition of the various denaturized alcohols on the market has been carefully kept secret by the proprietors, and M. Périssé found it necessary to employ a chemist, M. Boulanger, a specialist in this department of organic chemistry, to examine the different specimens submitted and determinne their composition, otherwise the tests would have had their scientific value materially diminished. The chemical examination showed that the materials employed as denaturants are practically limited to four, methylene (CH_4O); pyridine (C_5H_5N), or rather the multiple pyridic bases; acetone, contained in the methylene; and benzole. The alcohol itself is usually 90 per cent. strength, and the different samples examined by M. Périssé were found to have the following composition:

The French alcohol is prepared by taking 100 litres of 90 per cent. alcohol (that is, containing 10 per cent. of water) and adding 10 litres of methylene containing 25 per cent. of acetone and 5 per cent. of hydrocarbon impurities, and also adding 0.5 litre of benzine. This is the standard denaturized alcohol used in France under the existing legal requirements, notwithstanding the efforts of the Minister of Agriculture, the various agricultural societies, and the Automobile Club of France, to permit its modification.

In Austria there are three kinds of denaturized alcohol, the composition being held secret. Leaving aside the varieties intended for burning and for lamps, the variety employed for internal-combustion motors (*motorspiritus*) contains 0.5 per cent. of methylene and 2.5 per cent. of benzole. Germany, like Austria, permits several kinds of denaturized alcohol, according to the intended use. The motor alcohol of Germany contains 1 per cent. of methylene, 0.25 per cent. of pyridic bases, and 2 per cent. of benzole, and a small amount of violet coloring matter. The Italian method is to prepare an official denaturizing liquid, the composition of which is held secret, and 3 litres of this liquid are required to be added to each 100 litres of alcohol. Analysis shows that the denaturized alcohol contains 8.5 per cent. of methylene, 0.65 per cent. of pyridic bases, and about 1 per cent. of benzole, with a coloring of aniline violet.

M. Périssé discusses also alcohols which have been denaturized by the addition of benzole alone, but the results obtained are lacking in definiteness, owing to uncertainty as to the composition of the benzole obtainable at the exposition. In this connection M. Périssé calls attention to the method of preparing such an alcohol, due to M. Hache, this consisting in the addition of the benzole and other denaturizing materials and then redistilling the whole, the product thus consisting of alcohol charged with volatile hydrocarbons of about its own density and having the same boiling point of 78° C. This product contains about 33 per cent. of volatile hydrocarbons, and has been found to give a horse power

for a consumption of 600 grammes per hour, which is remarkably low for a fuel containing 66 per cent. of alcohol.

The method of conducting the tests was to equip the motor with the Renard dynamometer, set to a resistance capable of absorbing the full power of the engine. Any lower power was therefore indicated and measured by the extent to which the speed was reduced. The fuels were contained in three tanks, one containing carburetted alcohol for starting and warming up the engine, the second for supplying a standard alcohol, and the third containing the alcohol to be tested. Any one of these tanks could be switched into connection with the feed pipe to the carburetter of the engine, and thus comparative results could be secured without stopping the engine. The correct action of the engine was shown by the Mathot indicator and the speed of the dynamometer gave the information necessary for computing the power, and when all was running smoothly the fuel consumption was measured.

Detailed information concerning the consumptions for the different fuels is given in the original paper, but, in general the consumption ranged from 747 grammes to 1,048 grammes per hour per horse power developed, the best result being given by the Austrian alcohol, and the lowest by the Russian and Swiss products. The French alcohol required 932 grammes per horse power per hour, showing the room for improvement in this mixture, while the German *motorspiritus* gave a horse power for a consumption of 835 grammes per hour.

The data and results of these tests should be useful for those countries which have as yet not fallen into line in permitting the relief of denaturized alcohol from taxation, while the designers of motors for use with alcohol fuel will find much useful information in the report which M. Périssé has made.

A STUDY OF BEARING METALS.

FRICTIONAL CHARACTERISTICS OF BEARING METALS AND THEIR RELATION TO MICROSTRUCTURE.

Melvin Price—American Society of Mechanical Engineers.

NEARLY every problem in machine design has included in it the question of provision for rotating journals and their bearings. Years ago the question of friction was studied experimentally by Morin, and upon the results of those experiments by far the greater proportion of existing bearings has been designed. At the present time, however, engineers are called upon to deal with pressures and speeds so far in excess of those contemplated by General Morin that further investigations have been deemed advisable. At the recent convention of the American Society of Mechanical Engineers a paper was presented by Professor Melvin Price, upon the microstructure and frictional characteristics in bearing metals, this including reference to the work of some of the later investigators. Among these successors of Morin may be noticed especially the work of Charpy, upon the function of hard grains and of the plastic ground mass in the microstructure of alloys; and the theory of Professor Goodman upon the effect produced by elements of high atomic volume as distinguished from the effect of those of low atomic volume in bearing alloys. It was to compare the results obtained by Morin with these later theories that the experiments of Professor Price were undertaken, the methods of metallography being employed in the study of the physical nature of the materials, while some ingenious mechanical and electrical devices were used to determine the friction.

"The laws of friction as announced by Morin were as follows:

"(1) The friction between two bodies is directly proportioned to the pressure, *i. e.*, the coefficient is constant for all pressures.

"(2) The coefficient and amount of friction, pressure being the same, is independent of the areas in contact.

"(3) The coefficient of friction is independent of velocity, although static friction (friction of rest) is greater than friction of motion.

"In direct contrast with the above, we

find the modern beliefs regarding frictional behavior stated by Mr. John Goodman in a review of the results obtained from the testing machines of Thurston, Tower, and Stroudley, as follows:

"(1) The coefficient of friction for moderate pressures and speeds varies approximately inversely, as the normal pressure.

"(2) The frictional resistance varies as the area in contact, the normal pressure remaining constant.

"(3) At very low journal speeds the coefficient of friction is abnormally high; but as the speed of sliding increases from about 10 to 100 ft. per min. the friction diminishes, and again rises when that speed is exceeded, varying approximately as the square root of the speed."

Such contradictory results can only be due to differences in the conditions or the scope of the experiments, and it is these differences which are examined by Professor Price. It is recognized that because one surface is superposed upon another it does not necessarily follow that they are in contact. There are more probably a limited number of points in contact, their area being indeterminate, and when the nominal area is changed the actual area in contact may be only shifted in position to new bearing points without producing any definite change in the actual contact surfaces. Experiments appear to show that Morin's laws may be explained as being obeyed by bodies in contact only at small point areas at which they mesh deeply: that the modern laws are obeyed by bodies in better mechanical contact, but meshing less deeply.

The method employed by Professor Price consisted in the use of a revolving disc, set in motion by contact with a running belt, the disc being painted in alternate black and white quadrants and the retardation being observed through a vibratory stroboscope. By using different bearing metals comparative experiments were conducted, the uncertainty as to the amount of area in contact being eliminated as much as possible by reducing the bearing area under observation.

Experiments made with this apparatus gave data for the plotting of a number of curves, while microphotographs of etched sections enabled the physical constitution of the corresponding bearing alloys to be studied.

The results of the experiments are given in detail in the original paper, but an abstract of the conclusions may be given here. So far as the variation in the amount of the friction with regard to the velocity of sliding is concerned, it seems impossible to establish any definite law. The variations appear to be peculiar to the alloys themselves, although there are often partial similarities. Taking the question of abrasion as a possible basis of study. Here the hardness of the material comes into play, and from this point of view the "asperity" of the bearing metal may be considered. It appeared that mechanical imperfections, microscopical structural features, hard crystals of chemical compounds, and other foreign effects, which make up the *lower orders of asperity*, have a rather constant influence on the resistance. It also appeared that groups of alloys could be formed in which peculiarity of performance went hand in hand with one of the three constituents. This constituent was not noticed in the microstructure, and was called the silent constituent. It may be inferred that such constituents affect the grouping of the atoms, or even of the minute crystals, in such a way as to determine the feature of the higher *orders of asperity*.

It does not seem at all improbable that the lower orders of asperity exert a nearly or quite constant resistance, or that the higher orders exert resistances varying according to the microstructure, although it may also be true that the variations observed are resultants of two or more effects, either of which might be constant if taken separately, but that under varying conditions of speed various portions of each effect enter into the resultant.

With regard to the theory of Charpy as to the residence of the anti-friction properties of an alloy in the hard grains, this is not confirmed by the experiments of Professor Price. The pure metals performed with less resistance than the alloys, and the formation of isolated hard crystals tended to increase the resistance.

The conclusion of Professor Goodman, that the resistance is diminished when the third consituent of an alloy is a metal of

high atomic value, does not appear to be inconsistent with the results of the present experiments. While the investigations of Professor Price contain much that is most valuable and suggestive, he himself calls attention to the fact that they must be considered as but tentative, and not to be extended too far, but rather regarded as an effort to reconcile the work of Morin with that of more recent investigators.

COMPRESSION IN STEAM CYLINDERS.

EXPERIMENTAL INVESTIGATIONS INTO THE INFLUENCE OF COMPRESSION UPON THE ECONOMICAL PERFORMANCE OF STEAM ENGINES.

Dr. Herbert Klemperer—Verein Deutscher Ingenieure.

IT is now several years since the experiments of Professor Dwelshauvers-Dery called attention to the fact that the compression of steam into the clearance space of an engine cylinder might be a source of serious loss. Clearance space between the end position of the piston and the head of the cylinder is unavoidable, although it may be reduced to a minimum by care in design and construction, but it had been generally accepted, upon the statement of so high an authority as Zeuner, that the injurious effects of clearance were entirely neutralized when such a degree of compression was employed as would fill this clearance space with steam compressed up to the pressure of the incoming live steam. The experiments of Dwelshauvers, however, showed that increased clearance meant increased steam consumption, even if a corresponding degree of compression was used and the work which he did with the experimental engine in the mechanical laboratory at the university of Liége appeared to sustain his contention very fully. The papers by Dwelshauvers, as well as the discussions which followed, were fully reviewed at the time in these columns, but the question has been revived at the present time by the publication, in the *Zeitschrift des Vereines Deutscher Ingenieure*, of a new series of experiments upon the same subject in the mechanical laboratory of the technical high school at Dresden under the direction of Professor Mollier, these investigations being reported and discussed in an interesting manner by Dr. Herbert Klemperer.

The engine upon which the experiments were made was constructed especially for laboratory work, and is of the Corliss type, the point of cut-off being variable by hand, the governor acting only to prevent an excessive speed from being reached. The cylinder is provided with a steam jacket, and the heads are arranged to be moved in or out in such a manner that the clearance may be varied from the normal of 4.5 per cent. to any desired increase. The pipe from the boiler to the engine is only 13 metres long, well covered, and a separator placed close to the engines, and numerous tests have shown the steam to be of uniform quality, containing about 1 per cent. of moisture. The exhaust steam from the engine passed first into a receiver, between which and the condenser was placed a throttle valve. This arrangement was found necessary in order to obtain a back pressure high enough to enable the desired degrees of compression to be attained. The condensed steam was carefully collected and weighed, including the drip from the exhaust receiver and from the jacket. The engine was carefully tested for tightness of valves and piston, and all the testing instruments were calibrated with care.

The engine was connected to an independently-excited dynamo, the current being passed to a resistance of nickelin, and by the regulation of the load the speed of the engine could be maintained at any desired number of revolutions for the admission and cut-off selected. The general details of the trials appear to have been given every care, and the results are entitled to corresponding consideration.

Dr. Klemperer examines the theory of compression of steam, and accompanies each indicator card with an auxiliary diagram showing the condition of the steam during compression, the ordinates representing the quality of the steam considered in comparison with the specific volume of dry saturated steam of the same pressure,

while the abscissas represent the successive volumes during the compression.

Comparison of a series of diagrams, together with tabulated results of tests at various cut-offs and compressions show that the heat exchanges during compression bear an important relation to the economical performance of the engine. For the numerous curves and the tables of data and results the reader must be referred to the original paper, but in general the conclusions may be given here.

The results naturally varied somewhat with the operative conditions, including the ratio of cut-off, the presence or absence of steam in the jacket, and the degree of back pressure. In general, however, a moderate degree of compression was accompanied with a slight improvement in performance, beyond which there was a marked increase in steam consumption, reaching as high in some cases as more than 20 per cent. advance over the consumption at normal compression.

This loss is evidently due to the same cause as was ascertained by Professor Dwelshauvers, being due to what he called the anticipatory condensation of the exhaust steam as its pressure and temperature rose in the course of the compression. The compression does fill up the clearance space and raise the temperature to that of the incoming steam, but, as Professor Boulvin put it: "it is more economical to reheat the walls by live steam than by the work of compression, because this work, being derived through a cycle of low efficiency involves a large expenditure of heat."

Dr. Klemperer states the matter in much the same way when he says: "The condition under which compression is advantageous is that the temperature at the end of the compression shall not exceed that of the cylinder walls, so that the maximum economical compression at the end of the stroke is that corresponding to the temperature of the walls." If the compression is increased beyond this point the economy of the engine will fall off, and according to the experiments at Dresden, the steam consumption will increase in proportion to the ratio of the volume of the compressed steam to the volume of live steam in the cylinder.

WINDING ROPES FOR MINES.

CAUSES FOR THE REDUCTION IN STRENGTH OF WINDING ROPES FOR USE WITH MINE HOISTS.

J. A. Vaughan and W. M. Epton—Transvaal Institute of Mechanical Engineers.

WITH the continually increasing depth of mine workings in various parts of the world there has been shown a growth of interest in hoisting machinery and appliances, and several papers of importance upon this and allied subjects have been recently reviewed in these pages. Nearly all the discussions have related to the winding machinery itself, including the systems employed, the engines, motive power and similar features. In all of these methods, however, the winding rope itself forms an essential part, and upon its strength and durability the success of any system must depend.

In a paper recently presented before the Transvaal Institute of Mechanical Engineers, Messrs. J. A. Vaughan and W. M. Epton discussed the strength of winding ropes and the reduction in their sustaining power in the course of service, and some review of the results of such experience will be of interest to mine operators in other places.

A winding rope should be chosen in the first place with regard to the work it has to perform, and the conditions under which it is operated. The duties of different ropes employed under identically the same conditions are capable of comparison, but the duty of one particular rope in comparison with that of another rope working under different conditions is a difficult matter to determine. When, as in the first case, the operative conditions are the same, the duty may be determined by dividing the total amount of ore hoisted by the cost of the rope. A more general rule suggested by the authors is to divide the mileage run by the factor of safety, this latter term being estimated by considering the total effect of all the destructive influences, and

not merely the statical load. The deterioration of a winding rope may take either any, or all, of the three following forms:

1. Decrease in the sectional area of the wires:
2. "Fatigue" or change of state of the steel, *i. e.*, loss of certain desirable qualities, such as ductility, originally possessed by the material;
3. Discontinuity of the wires due to their breaking.

The oxidation of steel or iron, commonly known as rusting, is especially rapid and far-reaching, because the rust first formed does not protect the rest of the metal, but rather increases its corrosion. The simultaneous presence of H_2O, O_2 and an acid (generally H_2CO_3), is necessary for the rusting of iron, but little rusting occurs in the absence of any one of these there. Moreover, the presence of an alkali, or even an alkaline carbonate, prevents rusting.

In wrought or ingot iron the corrosion rises with the percentage of carbon, and this applies to steels with much combined carbon. Rusting is increased by galvanic action—as, for instance, tin-plate when the tin coating is broken. Similarly with iron railings coated with lead, corrosion occurs just above the junction of the metals. The same applies to copper-covered iron, the protection being satisfactory only so long as the coating is perfect. Galvanised steel (with zinc) on the other hand rusts less than steel, since zinc is attacked first, but it is very susceptible to chlorides (*e.g.* sea water), and also will not stand the action of the free acid in some mine waters. The thin coating of zinc on the wires of a winding rope will very soon be worn through at the places where external or internal rubbing occurs.

Regarding the deterioration due to "fatigue" or change of state of the steel, it is well known that the frequent application of a load, well below that producing stress up to the elastic limit, eventually produces "fatigue" in steel. Reversals of the load accelerate this action. The fatigue shows itself by the steel becoming brittle. Whether this is due to an alteration in the arrangement of the molecules of the steel, this changing from the fibrous to the crystalline structure is a point on which scientists do not agree. Most certainly the wire becomes brittle and behaves as if the structure of the steel had become crystalline.

In local practice it has certainly been found that the brittleness in a rope is much more marked when it is subjected in winding to a large number of reverse bends, and it is very probable that a winding engine with a light drum will also cause the same results on account of the uneven turning moment on the drum shaft. The writers have examined one winding plant where these results have occurred under the conditions stated. In this case the ropes only last about sixteen or eighteen weeks; broken wires begin to appear after the rope has been about a month in use, after which time the number increases very rapidly from week to week, until, in about the sixteenth or seventeenth week, as many as ten wires break each day. It is found that the condition of the wire is such that 180 degs. bend will break it, whereas it took eight or nine bends to accomplish this when the wire was new. In this particular case there was very slight frictional wear on the wires, which were practically their full size.

In another case, micro-photographs were taken of wires in a rope, samples being cut from a very much worn part, and also from the end which had been coiled spare on the drum and which had therefore been subject to very little stress, and it was found that in the former case the molecular structure was entirely different from that in the latter. In this instance, however, the wires were much reduced in size, due to wear, frictional or corrosive, or both. The former case cited, in which the rope has been put out of use on account of a very large number of breaks in the wires, is not a solitary case. Until further information as to the real cause of the deterioration is furnished, it is popularly attributed to "fatigue" of the steel, and it is generally supposed that the more bendings there are in the journey of the rope, and the more frequently reversals occur, the shorter the life that may be looked forward to for the rope. There are, however, other causes that may tend to the peculiar effect of loss of ductility, while original size and appearance remain practically intact.

Safety in winding ropes can be secured

only by frequent, careful inspection. In the Transvaal a daily examination is required besides a thorough inspection once a month, the rope being thoroughly cleaned at selected places in order that its true condition may be ascertained. By running the winding engine slowly the rope may be examined throughout its entire length, the signals being so arranged that it can be stopped immediately upon call for a special inspection of any particular spot.

The places in a rope demanding especial attention are those where contact with sheaves and pulleys occur at acceleration or retardation periods of the hoist, also the portion nearest the skip or cage where there is apt to be an accumulation of moisture, both external and internal. It is recommended that recapping be done at intervals of about three months, thus shifting the points of greatest wear and at the same time removing the portion of the rope subjected to the most severe kinetic stresses.

A SEA LEVEL CANAL FOR PANAMA.

A CONVERTIBLE LOCK-SYSTEM FOR ULTIMATE TRANSFORMATION INTO A SEA-LEVEL CANAL.

Philippe Bunau-Varilla—Académie des Sciences.

NEARLY all of the plans which have been proposed for the Panama Canal involve a number of locks, these permanently maintaining a summit level, and intermediate levels above the sea, and to these must be added the sea-level plan, which calls for the cutting of the whole channel down to the level of the ocean. To these we now have another plan due to M. Bunau-Varilla, and described by him in a communication presented to the French Académie des Sciences, and further elaborated in a letter which he has addressed to the President of the United States. This plan may be called a combination of the previous ones in that it includes the construction of a summit-level lock canal, but so arranged that it may gradually be lowered as the traffic increases, until ultimately the sea level is reached. The method by which this may be accomplished is explained in detail, and the whole scheme possesses some ingenious original features.

In order that the canal may be opened for traffic within the shortest possible time, M. Bunau-Varilla proposes to begin with a summit level of 130 feet. The cut at Culebra has already been brought down to a level of 150 feet, so that a further reduction of 20 feet would be sufficient; this summit level extending across the central massif, between Gamboa and Paraiso. This work, it is estimated, could be completed within four years. At each end of this summit level would be placed two locks, of 35 feet lift, or a total of 70 feet, bringing the channel down to the 60-foot level, which again would be brought down to sea level on the Atlantic side by a flight of locks at Bohio, and on the Pacific side by two locks, at Pedro Miguel and Miraflores, or other suitable points.

The auxiliary works include a dam at Bohio, and a spillway, and the plan adopted for this by M. Bunau-Varilla is practically that proposed by the late George S. Morison, consisting of a mass of earth and clay from 2,500 to 3,000 feet thick, hydraulically deposited between two enclosing dams, and forming a solid neck of land across the valley. The seepage beneath such a dam, only 60 feet high, would be insignificant, practically less than the loss by evaporation.

The dam at Gamboa should be built of reinforced concrete, and may be constructed to a height of 150 feet above sea level in the opinion of M. Bunau-Varilla, within the four years required for the works at Culebra, and this time is also ample for the construction of the locks and other auxiliary works.

Such a canal, it is estimated, would suffice for a traffic of 50,000,000 tons or five times the present capacity of the Suez Canal, while at the same time the level could be gradually reduced and the locks removed until a sea level channel is attained throughout.

The method by which this latter result may be accomplished constitutes the characteristic feature of the scheme. The principle of the method appears in a modification in the construction of the locks and

lock gates. In the ordinary construction it would be altogether possible to deepen an upper level to any desired extent with the exception of the end portions near the locks, but to effect the complete lowering of the channel by the removal of the locks themselves would involve a serious interruption to traffic. The modification of M. Bunau-Varilla to avoid this difficulty is simplicity itself, since it requires merely the original construction of the lock chambers and gates to the full depth of the reduction in lift at each point, the full depth also being carried back a few hundred feet from the lock at each end of a level. This would render it impossible to effect a continual deepening of the stretch between the locks without any further consideration of either gates or lock masonry.

To use the words of M. Bunau-Varilla: "The method consists simply in giving to the gate above the lock the same height as the gate below, and the same level of foundation. Of course the ground forming the bottom of the summit level will have to be excavated down to the level of the bottom of the adjoining navigable level, for a distance of 400 to 500 feet above the gate of the lock. It can no longer be limited by the wall which in ordinary locks supports the gate above, and at the same time acts as a retaining wall for the ground above.

"The locks being thus arranged, if we dredge five feet into the bottom of the summit level we shall not touch during such dredging any vital part of the canal; the locks will remain precisely as they are. When the dredging is finished, as we have five feet too much depth of water in the summit level, there is nothing to prevent lowering the water level five feet.

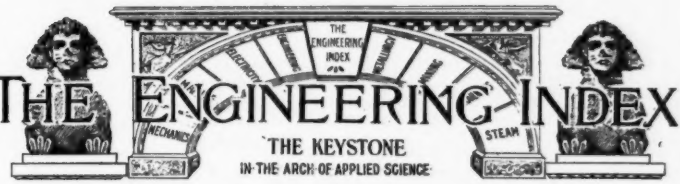
This will not in the least interfere with the operation of the locks. When this is done the ships will still find the 35 feet depth of water which they require, and nothing will have been changed, except that the canal will then have the summit five feet less above the sea level than before.

This operation may be repeated until the entire lift has been removed, after which the lock gates are no more required and may be taken off, navigation not having been interrupted at all. In this way a gradual transformation from a lock canal into a sea level channel may be going on continuously, while at the same time traffic is going on. At Suez the canal was cut to sea level at once, the sandy isthmus being sufficiently near the level of the sea to render this a comparatively simple matter. The channel, however, has been both deepened and widened, without interrupting traffic.

An ingenious feature of the scheme of M. Bunau-Varilla is that for the disposal of the spoil removed in the deepening of the upper portion of the channel. This plan is nothing more nor less than the conveyance of the earth in scows up to the lake formed behind the Gamboa dam. Even if the canal is finally excavated to a bottom width of 300 feet it is estimated that the amount of earth would form a deposit only eight feet in depth on the bottom of the lake, and since the depth of water would be 145 feet.

"This solution can be easily realized by connecting the waters of the lake with those of the summit level by a double flight of locks. The material extracted by the dredges would be dumped into scows which would be tugged along the summit level in the channel opened outside of the navigation channel, and after ascending the flight of locks, go into the Gamboa lake and simply unload themselves by opening their bottom gates."

There are numerous details in the plan which appear to have been worked out with care, and the whole scheme demands the consideration which it will doubtless receive at the hands of the Commission and the Advisory Board. The real point to be considered about it is whether a sea level canal is really desirable at all. M. Bunau-Varilla admits that a canal with 130-foot summit level, and with eight locks, is fully capable of taking care of an annual tonnage fully five times as great as that acquired by the Suez Canal after thirty years of operation. Such being the case, there is every reason to believe that the 20.75 metre (68 feet) level approved by the *Comité Technique* would suffice for any traffic which might be expected, and certainly that the 9.75 metre level (32 feet) would be sufficient. If these plans, so fully worked out, are ample, there need be no further preparation made for a sea level channel, and the ingenious plan of M. Bunau-Varilla would be found unnecessary.



The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

Civil Engineering	599	Mechanical Engineering	613
Electrical Engineering	606	Mining and Metallurgy	624
Industrial Economy	611	Railway Engineering	631
Marine and Naval Engineering	612	Street and Electric Railways	636

CIVIL ENGINEERING

BRIDGES.

Arch.

Concrete Arch Over the River Tay at Kinclaven. Illustration with brief description of a structure built entirely of concrete, faced with red freestone. 700 w. Engng—May 12, 1905. No. 69830 A.

Concrete-Steel Arch Bridge at Kankakee, Illinois. J. B. Marsh. Illustrated detailed description of the construction. The bridge is so designed that the grade forms a vertical curve, with the center 2½ feet higher than the ends. General discussion. 4300 w. Jour W Soc of Engrs—April, 1905. No. 69686 D.

Erection of the Bellows Falls Arch Bridge. Brief illustrated description of a bridge across the Connecticut River, of interest on account of its long span, and the type of suspended floor. 1200 w. Eng Rec—April 29, 1905. No. 69318.

Reinforced Concrete Arch Bridge at

We supply copies of these articles. See page 638.

Yorktown, Ind. Illustrated description of the construction of a reinforced concrete arch bridge of 95-ft. span, with the thrust resisted by a tie connecting the skewbacks across the bed of the stream. It is the longest span of the Luten type ever erected. 1600 w. Eng News—May 11, 1905. No. 69492.

Blackwells Island.

Details of Blackwells Island Bridge Superstructure. An illustrated detailed description of this bridge from East Fifty-ninth St., Manhattan, across the East River and Blackwells Island, New York, to Ravenswood. 2000 w. Eng Rec—May 20, 1905. Serial. 1st part. No. 69812.

Cantilever.

The Mississippi River Bridge at Thebes. Illustrated detailed description of interesting features of this large cantilever bridge. 1500 w. R R Gaz—Vol. XXXVIII., No. 21. No. 69874.

The Mississippi River Cantilever Bridge at Thebes, Ill. Illustrated detailed description of one of the most notable bridges in the United States, costing about $2,800,000. 4500 w. Eng News—May 11, 1905. No. 69494.

Drawbridge.

The Hansa Bridge at Stettin (Die Hansabrücke zu Stettin). A fully illustrated account of the new bridge over the Oder at Stettin. There are two shore spans of 37.2 metres, and an electrically operated rolling-lift draw of 18 metres. 6000 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 29, 1905. No. 69707 D.

Scherzer Lift Bridge Over the River Swale; Foundation Details. Drawings and notes introductory to a description of the erection and of the opening leaf. 500 w. Engng—May 12, 1905. Serial. 1st part. No. 69829 A.

Short Span Bascule Bridge on the Pittsburg, Fort Wayne & Chicago Ry. Illustrations, with brief description of a double-track, short-span, single leaf bascule bridge of peculiar design, at Delphos, Ohio. 600 w. Eng News—May 25, 1905. No. 69863.

Erection.

Substructure and Falsework Construction for the Gilbertsville Bridge. Illustrates and describes the construction of this bridge across the Tennessee River at Gilbertsville, Ky. The substructure for the main spans consists of six river piers and two shore piers, all made of reinforced concrete. 1000 w. Eng Rec—May 20, 1905. No. 69807.

Oder.

Plans for a Combined Railroad and Highway Bridge over the Oder at Neusalz (Entwurfe für eine Vereinigte Eisenbahn- und Strassenbrücke über die Oder bei Neusalz). F. Dircksen. With details of the designs of various competing firms, including braced arches, trusses, and cantilevers. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—April 15, 22, 1905. No. 69700 each D.

Ottawa River.

The Bout de L'Isle Bridge. J. L. Morris. Illustrated description of a bridge crossing the east and west branches of the Ottawa River just above the junction with the St. Lawrence. 2000 w. Can Soc of Civ Engrs—April 20, 1905. No. 69647 C.

Piers.

Design and Construction of High Bridge Piers of Reinforced Concrete. William M. Torrance. Gives calculations made for the design of piers of a bridge across the Tennessee River, on the Louisville Div. of the Illinois Central R. R. Also gives notes on construction. Ills. 4000 w. Eng News—May 25, 1905. No. 69865.

Plate Girder.

The Pine Creek Long-Span, Plate-Girder Bridge. Illustrated description of a double-track skew deck bridge having three duplicate main spans of 127 ft. 10 in., and one 33 ft. 8 in. approach span. 1500 w. Eng Rec—May 6, 1905. No. 69454.

Railroad Bridges.

The Development of Railroad Bridge Design and Construction. Henry W. Hodge. A general review of progress, with illustrated examples of modern work and description of details in present practice. 3000 w. R R Gaz—Vol. XXXVIII., No. 18. No. 69430.

Reconstruction.

The Reconstruction of the Maximilian Bridge at Munich (Die Rekonstruktion der Maximiliansbrücke in München). Prof. Mörsch. An account of the method employed in replacing a hinged masonry arch which had slipped from its hinges. 2000 w. Schweiz Bauzeitung—May 13, 1905. No. 69733 B.

The Reconstruction of the Point Bridge, Pittsburg. Describes work on this bridge across the Monongahela River, describing the old bridge, the condition before repairs, and the reinforcement of anchorages in the present article. Ills. 2700 w. Eng Rec—May 6, 1905. Serial. 1st part. No. 69450.

Renewals.

The Erection of the Short Line R. R. Bridge at Minneapolis. An illustrated article describing the building on the same alignment, without interrupting traffic, of a heavy double-track structure to replace a light single-track bridge across the Mississippi River. 1200 w. Eng Rec—May 20, 1905. No. 69806.

We supply copies of these articles. See page 638.

Suspension.

Making the Cables of a Large Suspension Bridge. Isaac Harby. A detailed description of this work on the Williamsburgh Bridge, across the East River, at New York. Gives brief description of the bridge, also. Ills. 6500 w. Cassier's Mag—May, 1905. No. 69283 B.

Transporter.

Transporter Bridge Over the Mersey. An illustrated description of a bridge of the "suspended ferry" type, recently completed. 2500 w. Engr, Lond—May 5, 1905. No. 69599 A.

Trusses.

A Comparison between the Exact and Approximate Methods of Computation for Bridge Trusses (Genauere Behandlung Statisch Unbestimmter Parallelträger und Vergleich mit der Näherungsrechnung). Friedrich Hartmann. With tables of both computations, showing variations of 25 to 33 per cent. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—April 28, 1905. No. 69730 D.

Some Primary Truss Principles. Myron S. Falk. Shows that trusses whose outlines contain rectangles, or even other polygonal figures, may be stable and statically determinate. 1700 w. Sch of Mines Qr—April, 1905. No. 69634 D.

Viaduct.

The Austerlitz Viaduct over the Seine (Viaduc d'Austerlitz sur la Seine). A. Dumas. An illustrated description of the bridge recently completed to carry the Metropolitain railway across the Seine at Paris. 3000 w. 1 plate. Génie Civil—April 29, 1905. No. 69719 D.

The Southwestern Ave. Boulevard Nine-Track Viaduct in Chicago. Illustrated description of an unusually wide viaduct made necessary by track elevation improvements. 2000 w. Eng Rec—April 29, 1905. No. 69319.

CONSTRUCTION.

Balcony.

Semicircular Symmetrically Loaded Balcony Beams (Der Halbkreisförmige und Symmetrisch Belastete Balkonträger). G. Ramisch. A mathematical treatment of the forces acting upon a semi-circular beam with ends built into a wall, forming a balcony. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—April 7, 1905. No. 69726 D.

Building Construction.

Structural Features of Rockefeller Building at Cleveland. Illustrated description of interesting features of a 17-story, steel-cage, fireproof office building. 1500 w. Eng Rec—May 27, 1905. No. 69912.

Dams.

Note on the Theory of Unsymmetrical Masonry Dams. Prof. W. C. Unwin. Explains a method of determining the distribution of the shearing stress on horizontal sections. 1600 w. Engng—April 21, 1905. No. 69336 A.

Further Note on the Theory of Unsymmetrical Masonry Dams. Prof. W. C. Unwin. Examines the stresses in a triangular dam, by the method already given. 1200 w. Engng—May 12, 1905. No. 69827 A.

Doors.

A Novel Balanced Door. Illustrated description of the invention of Joseph Henry Dierickx, a Belgian inventor, which consists of two leaves so pivoted that they will slide into partitions. 500 w. Sci Am—May 6, 1905. No. 69392.

Folding Doors for Freight Houses and Warehouses. Illustrates and describes the Ritter door, and the Cross door, two types which fold vertically. 600 w. Eng News—May 4, 1904. No. 69365.

Foundations.

Concrete Foundations of the New Passenger Station, Washington, D. C. Day Allen Willey. A brief description of this interesting edifice, giving details of the elaborate substructure. Ills. 1200 w. Sci Am—May 20, 1905. No. 69621.

Underpinning and Protecting the Foundations of the Times Building, New York. Illustrates and describes methods of underpinning the building at the corner of Spruce St. and Park Row, made necessary in constructing the City Hall loop of the Rapid Transit Subway. 1200 w. Eng Rec—May 27, 1905. No. 69910.

Pile Driving.

The Use of a Novel Water Jet for Driving Piles for the Sandy Hook Proving Ground Railroad Trestle. Sherman A. Jubb. An illustrated description of the method used in pile sinking. 1200 w. Eng News—May 4, 1905. No. 69366.

Power House.

A River-Bed Power House. John M. Bruce. Illustrates and describes a power house and pulp mill at Berlin, N. H., as an interesting example of concrete construction under great natural difficulties. 1200 w. Cement Age—April, 1905. No. 69353.

The Use of Concrete in an Electric Power Station. Eugene B. Clark. Read before the Chicago Branch of the Am. Inst. of Elec. Engrs. Considers the use of cement in foundations, floors, roofs, &c., especially considering a recently completed plant in South Chicago. 3000 w. Eng News—May 4, 1905. No. 69364.

We supply copies of these articles. See page 638.

Reinforced Concrete.

A Prominent Building of Reinforced Concrete Construction. Illustrated description of the Pugh Power Building, in course of construction in Cincinnati. 2000 w. Cement—May, 1905. No. 69840 C.

A Reinforced Concrete Building for a Philadelphia Printing Company. Illustrates and describes interesting work in the reconstruction of a brick building, to render it more nearly fireproof. 1300 w. Eng Rec—May 13, 1905. No. 69574.

Concrete Construction. Edward Atkinson. Discusses the use of concrete construction for factories, shops and other works, and for dwelling houses and warehouses. 2400 w. Cement Age—April, 1905. No. 69352.

Distribution of Shear Over Section, for Reinforced Concrete Beams. John G. Little. Gives solution. 300 w. Eng News—May 25, 1905. No. 69864.

Reinforced Concrete Building Work for the United Shoe Machinery Co., Beverly, Mass. George P. Carver. Illustrated detailed description of a plant consisting of ten buildings, all built of reinforced concrete. The construction work is fully described. 5000 w. Eng News—May 25, 1905. No. 69861.

Reinforced Concrete. Editorial discussion of this building material and its use. 2200 w. Engng—April 28, 1905. No. 69479 A.

Static Investigation of a Curved Prismatic Compound Beam (Statische Untersuchung eines Einfach Gekrummten Stabförmigen Verbundkörpers). G. Ramisch. An examination of the distribution of stresses between the iron and concrete in a deflected beam. 3500 w. Oesterr Wochenschr f d Oeffent Baudienst—April 29, 1905. No. 69762 D.

The Design of Reinforced-Concrete Beams. George H. Blakeley. Presents some formulas for transverse strength of the simple case of reinforced concrete slabs for floor construction. 4000 w. Eng Rec—May 27, 1905. Serial. 1st part. No. 69909.

The Iowa State Highway Commission's Designs for Culverts. T. E. McDonald. Read before the Iowa Cement Users' Assn. On designs for reinforced concrete box culverts, and their construction. 2500 w. Munic Engng—May, 1905. No. 69542 C.

See Civil Engineering, Bridges.

Roads.

Marsh Roads. Stillwell H. Townsend. From a paper in the Report of the N. J. Commissioner of Highways for 1904. Describes the construction of a road through the salt marsh from Rio Grande to Holly Beach. 800 w. Eng Rec—May 13, 1905. No. 69573.

The Charles River Speedway of the Boston Metropolitan Park System. William T. Pierce. Illustrated detailed description of a speedway costing about $450,000. 2500 w. Eng Rec—April 29, 1905. No. 69321.

Steelwork.

Steelwork in the Twin City Rapid Transit Company's Power House, Minneapolis. Describes the steel work of a building at present containing about 2,060 tons of structural steel, illustrating details. 2200 w. Eng Rec—May 13, 1905. No. 69576.

Tunnels.

The First Street Tunnel, Washington, D. C. Illustrated description of construction work on the double-track tunnel being built to connect the passenger tracks of the Pennsylvania R. R. with the new union terminal station. 2000 w. Eng Rec—May 20, 1905. Serial. 1st part. No. 69805.

MATERIALS OF CONSTRUCTION.

Bricks.

Glass Paving Bricks. A. M. Thackara. Describes the processes used in making artificial stone, paving brick and other products from old glass, as manufactured in France under the Garchey patents. 1600 w. Eng Rec—May 20, 1905. No. 69809.

Results of Tests of Common Building Brick for the Bureau of Buildings, New York City. Ira H. Woolson. Reports tests of transverse and crushing strength, also absorption, fire, and freezing tests. 2700 w. Clay Rec—April 29, 1905. No. 69377.

Cement.

A Comparison of the Theoretical with the Actual Fuel Consumption in Cement Burning. Henry S. Spackman. Read before the Assn. of Am. Port. Cem. Mfrs. An explanation of the methods of making calculations, giving the results. 3500 w. Eng Rec—April 29, 1905. No. 69320.

Cement Testing. Robert Gray. Describes briefly methods of testing to determine the quality. Ills. 1200 w. Yale Sci M—May, 1905. No. 69839 C.

Portland Cement. H. K. G. Bamber. Read before the Soc. of Archts. Describes processes of manufacture, considering particularly cement manufactured with chalk and clay. Also points on the testing of cement. 6500 w. Archt, Lond—April 21, 1905. No. 69324 A.

Prospecting and Sampling Deposits of Raw Material for Portland Cement Manufacture. Gives briefly instructions laid

down by Albert V. Bleininger in a report to the Ohio Geological Survey. 2500 w. Eng News—May 11, 1905. No. 69493.

Recent Results Obtained with the Kent Mill as a Fine Grinder. George H. Fraser. Address before the Assn. of Am. Port. Cement Mfrs. upon the grinding of cement. 4000 w. Cement—May, 1905. No. 69841 C.

Slag Cement. W. B. Ruggles. Reviews the early use of this material, the industry in the United States, and recent advances. 2000 w. Ir Age—May 18, 1905. No. 69611.

Tests of Cements at the Watertown Arsenal. James E. Howard. Read before the Assn. of Am. Portland Cem. Mfrs. Report of tests made during the past four years. 4500 w. Eng Rec—May 6, 1905. No. 69451.

The Government Cement Mill at Roosevelt, Arizona. H. B. Connor. Gives a statement of the amount saved by manufacturing on the ground the cement needed for the construction of the Salt River reclamation project, describing the plant. 1500 w. Min Wld—May 20, 1905. No. 69693.

The Influence of Sulphates on the Setting of Cement (Influence des Sulfates sur la Prise du Ciment). Louis Périn. With diagrams showing the effect of the addition of a small quantity of plaster to Portland cement. 1500 w. Génie Civil—April 15, 1905. No. 69714 D.

Stone.

Quarrying and Crushing Stone. J. Crow Taylor. Information of interest in regard to the stone-crushing industry, giving figures relating to the quarrying and crushing of limestone. 2000 w. Munic Engng—May, 1905. No. 69540 C.

MEASUREMENT.

Geodesy.

Report of the Equatorial Geodetic Commission (Rapport Présenté au Nom de la Commission Chargée du Contrôle Scientifique des Operations Géodésiques de l'Equateur). Describing the work of the French expedition in Ecuador during 1904. 3500 w. Comptes Rendus—April 10, 1905. No. 69721 D.

Surveying.

The Laying Out of City Lots Bounded by Curved and Straight Lines. Ernest McCullough. Gives an explanation of the practice followed by the writer, illustrating by plan. 1100 w. Eng News—May 11, 1905. No. 69497.

The Practice of Our Profession and Suggested Reforms. A. G. Cross. Read before the Quantity Surveyors' Assn. The first part of the paper is a plea for a uniform system of measurement in England; the second part deals with reforms in the employment and payment of the quantity surveyor. 6500 w. Builder—April 22, 1905. No. 69323 A.

The Stadia-Intersection Method for Topographical Surveys. Prof. L. E. Ashbaugh. Describes a method of intersections from stadia base lines which has proved efficient and rapid in securing desired results. General discussion. 5500 w. Jour W Soc of Engrs—April, 1905. No. 69687 D.

Temperatures.

See Civil Engineering, Waterways and Harbors.

Viagraph.

The Viagraph: An Instrument for Measuring Road Wear. Charles Lavell. Illustrated description of an ingenious invention for measuring and registering wear in road surfaces. 500 w. Sci Am—May 13, 1905. No. 69487.

MUNICIPAL.

Paving.

Concrete Paving and Paving Materials. H. L. Weber. From a paper before the Ohio Soc. of Surv. & Civ. Engrs. Directions for the construction of concrete roadways, their foundations, pavement, &c. Ills. 1200 w. Munic Engng—May, 1905. No. 69541 C.

Pollution.

Report of the New York Bay Pollution Commission. Extracts from the report, showing reasons for the unqualified disapproval of the Passaic Valley trunk sewer scheme. Editorial also. 5500 w. Eng News—May 1, 1905. No. 69370.

Sewers.

Concrete in Sewer Construction. W. C. Parmley. Discusses the advantages of concrete as a material aid in comparative cost, and gives notes from personal experience. 4500 w. Cement Age—May, 1905. No. 69896.

Sewage Discharge into New York Bay. Review of the report of the New York Bay Pollution Commission. Map. 2700 w. Eng Rec—May 6, 1905. No. 69452.

Sewer Tunneling with a Shield in Cleveland. J. M. Estep, in the *Polytechnic*. An interesting account of the construction of a sewer under conditions that make the work very expensive. 1800 w. Eng Rec—May 6, 1905. No. 69449.

The New Outfall Sewer at Los Angeles. Illustrated detailed description of work under construction. 1800 w. Eng Rec—May 13, 1905. No. 69570.

WATER SUPPLY.

Coney Island, N. Y.

A High Pressure Water System at Coney Island, N. Y. Illustrates and de-

scribes the system under construction which will furnish fire protection to this seashore summer resort. 1800 w. Eng Rec—May 20, 1905. No. 69813.

Copper Sulphate.

Copper as an Algicide and Disinfectant in Water Supplies. Karl F. Kellerman. Abstracted from Bul. No. 76 of the Bureau of Plant Ind., Dept. of Agri. Gives results of laboratory work, and practical applications of this method. 2200 w. Sci Am Sup—May 20, 1905. Serial. 1st part. No. 69628.

Dams.

See Civil Engineering, Construction.

Drinking Water.

Desert Plants as a Source of Drinking Water. Frederick V. Coville. An illustrated article giving information in regard to these plants, and the ability of animals feeding upon them to go without water; also describes an Indian's method of obtaining water from them. 2500 w. Sci Am Sup—May 27, 1905. No. 69870.

Filtration.

The Work of the Philadelphia Water Filters. Notes taken from an address by John W. Hill before the Engng. Soc. of Princeton University. 1200 w. Eng Rec —May 13, 1905. No. 69571.

Irrigation.

Irrigation in Canada. An account of work accomplished and projected in the Saskatchewan valley. 1500 w. Engr, Lond—May 12, 1905. No. 69835 A.

Mechanical Filters.

Tests of Copper and Iron Sulphates and Lime with Mechanical Filters at Anderson, Ind. Information from a paper by C. Arthur Brown, read before the American Water Works Association. 2500 w. Eng News—May 25, 1905. No. 69866.

Meters.

Meters for Fire Service. Gorham Dana. Discusses the question of metering fire service connections from public water systems, different types of meters, and gives table of tests showing effect of meters on flow of water. Ills. 5500 w. Ins Engng—May, 1905. No. 69876 C.

Pollution.

Report on the Pollution of Lake Champlain, the Boguet and Au Sable Rivers by Wood Pulp Mill Refuse and by Algæ. Abstracts of the reports of Olin H. Landreth and of G. C. Whipple, giving conclusions and recommendations. 8000 w. Eng News—May 25, 1905. No. 69862.

Private Companies.

The Eminent Domain of Private Water Companies. Houston Dunn. Discusses the growing menace of private ownership and matters of related interest. 2500 w. Ins Engng—May, 1905. No. 69877 C.

Pumping.

See Mechanical Engineering, Hydraulics.

Purification.

The Coagulation and Precipitation of Impurities in Water Purification. Joseph W. Ellms. Read before the Cincinnati Sec. of the Am. Chem. Soc. Comments on observed facts in water purification in the light of physical chemistry, describing investigations made of the Ohio River water. 3800 w. Eng Rec—May 13, 1905. No. 69575.

Reservoirs.

A Concrete Settling Reservoir at McKeesport, Pa. The reservoir described and illustrated was built by the National Tube Co., to purify the water of the Monongahela River to render it fit for use in the boilers and hydraulic machinery. 2000 w. Eng Rec—May 27, 1905. No. 69911.

Completing the Jerome Park Reservoir. An illustrated article reviewing briefly the Croton reservoirs and describing the new reservoir at Jerome Park. 1800 w. Sci Am—May 13, 1905. No. 69485.

The Cross River Reservoir for the Water Supply of New York City. Describes briefly this new reservoir of 10 billion gallons capacity, to be built to store the surplus water of an easterly tributary of the Croton River. Ills. 1100 w. Eng Rec—May 20, 1905. No. 69808.

Sanitation.

Sanitary Engineering Work in a Large Residence. Illustrated description of the design of the plumbing, heating, ventilation, and lighting systems for a house at Chestnut Hill, Mass. 2000 w. Eng Rec —April 29, 1905. No. 69322.

Tanks.

How to Set Up Wood Stave Tanks. R. Stuart Browne. An interesting description of methods of building and tearing down wood stave tanks, taken from advance sheets of a new catalogue of the Redwood Mfg. Co. 1300 w. Min & Sci Pr—April 22, 1905. No. 69292.

WATERWAYS AND HARBORS.

Anchor Ice.

Formation of Anchor Ice, and Precise Temperature Measurements. Dr. Howard T. Barnes. Investigations into the formation of slush or frazil ice in streams, and its relation to the temperature of the water. The apparatus for measuring the temperatures of the streams is very fully discussed. 7500 w. Trans Am Soc Mech Engrs—No. 070, June, 1905. No. 69557 C.

We supply copies of these articles. See page 638.

The Elevators at the St. Louis Water Works. E. E. Wall. An account of the trouble caused by anchor or needle ice in the wet well at the Chain of Rocks, and the elevators built to remove it. Ills. 700 w. Eng Rec—May 20, 1905. No. 69810.

Canals.

A New Baltic Black Sea Canal Scheme. Briefly outlines the plan suggested by M. W. von Rukteschell, a Russian engineer. It is called the Riga-Cherson Canal scheme, and utilizes the Duna and Dnieper rivers with a connecting canal. 900 w. Engng—May 12, 1905. No. 69832 A.

Channels.

Natural and Artificial Forms of River Channels (Natürliche und Künstliche Formen des Flussgerinnes). Valentin Lapaine. An examination of the natural tendency of streams to flow in curved channels, suggesting that artificial controlling works should be designed accordingly. 2000 w. Oesterr Wochenschr f d Oeffent Baudienst—April 22, 1905. No. 69760 D.

Dams.

See Civil Engineering, Construction.

Docks.

Reconstruction of Singapore Docks and Wharves. Describes the proposed reconstruction of wharves and extension of dock accommodations, and other improvements under consideration. 5000 w. Far East Rev—March, 1905. No. 69465 D.

Dredge.

The Submerged Jet Dredge. H. L. Lewis. Description of J. T. Johnson's patent, giving plan of pressure pipes and floats. 900 w. Min Jour—April 29, 1905. No. 69455 A.

Dry Dock.

The Construction of a Timber Dry Dock. G. B. Ashcroft. Plates and detailed description of a dry-dock in Baltimore which has been in satisfactory operation since 1901. Ills. 8000 w. Can Soc of Civ Engrs—April 20, 1905. No. 69644 D.

Flow.

Records of Blow at Current Meter Gaging Stations When the Streams Are Subject to Ice. F. H. Tillinghast. A study of the flow of water under ice, giving tabulated measurements. 1500 w. Eng News—May 11, 1905. No. 69496.

The Mean Velocity in Natural and Artificial Channels (Die Mittlere Profilgeschwindigkeit in Natürlichen und Künstlichen Gerinnen). Johann Hermanek. An examination of the various formulas for the flow of water, with especial reference to the determination of the coefficients. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—April 21, 1905. No. 69728 D.

Flumes.

Flumes for Transporting Logs, Lumber, and Sugar Cane. Photographs and description of flume construction. 3000 w. Eng News—May 18, 1905. No. 69629.

Harbor Improvements.

Improvement of the Harbor of Manila. An illustrated description of a public work nearing completion. 2800 w. Far East Rev—March, 1905. No. 69464 D.

Pier and Bulkhead Construction in New York Harbor. Sidney W. Hoag. Abstract of a paper before the Munic. Engrs. of N. Y. A review of the methods and work during the past thirty years of the N. Y. Dock Dept. in the construction of wharfage structures. Ills. 2500 w. Eng News—May 18, 1905. No. 69630.

Port Colborne Harbor Works. J. M. Hogan. Illustrates and describes important works comprising new docks, excavation of channels and two large breakwaters to the east and west of this port, situated at the Lake Erie end of the Welland Canal. 3500 w. Can Soc of Civ Engrs—Feb., 1905. No. 69645 C.

Notes on the Improvement of River and Harbor Outlets in the United States. D. A. Watt. A study of the conditions of several localities before and after improvement, giving a summary of the principles corroborated and the generally accepted theories. Ills. and maps. 6500 w. Pro Am Soc of Civ Engrs—May, 1905. No. 69879 E.

The Manila Harbor Improvements. Brief illustrated account of the dredging work and breakwater construction. 1000 w. Eng Rec—May 27, 1905. No. 69908.

Lighthouses.

See Electrical Engineering, Illumination.

Protection Works.

The Efficiency of the Protection Works of the Salzkammergut Lakes (Die Verwertung des Retentionsvermögens der Salzkammergut Seen). Ernst Lauda. A discussion of the regulation works of the Traun, and the lakes in the Salzkammergut district of Styria, Austria. Two articles. 1000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—April 28, May 5, 1905. No. 69729 each D.

River Regulation.

Correction of the River Drave by Sunken Trees (Ueber eine Anwendung von Sinkbäumen am Drauflusse). Anton Weber. A description of the method of sinking weighted trees to form a correcting embankment on the Drave, near Pettau, in Styria. 2000 w. 1 plate.

We supply copies of these articles. See page 638.

Oesterr Wochenschr f d Oeffent Baudienst—April 29, 1905. No. 69761 D.

The Reclamation of One Million Acres of Swamp Land in California. Rufus P. Jennings. States the conditions of the Sacramento River and the proposed plan recommended by a Commission of engineers for concentrating the flow. Map and Ills. 2000 w. Eng Rec—May 6, 1905. No. 69447.

Victoria Falls.

The Physical History of the Victoria Falls. Abstract of a paper by A. J. C. Molyneaux in the *Geographical Journal.* Claims the combination of cañon, gorge, chasm, and falls is due to erosion, and the constant reducing action of the Zambesi River. Ills. 900 w. Nature—April 27, 1905. No. 69460 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Exchange.

The Practical Management of Maintenance and Operation of a Telephone Exchange. C. E. Stinson. Read before the Ohio Ind. Telephone Assn. Discusses details of importance in successfully conducting an exchange of 9,000 telephones. 2500 w. Elec Rev, N Y—April 29, 1905. No. 69277.

Printing Telegraph.

Barclay's Printing Telegraph. Illustrated description of the apparatus invented by John C. Barclay, as embodied in the patent specification. 1800 w. Sci Am Sup—May 27, 1905. No. 69871.

Space Telegraphy.

Regulations for Space Telegraphy in the German Empire (Regelung der Funkentelegraphie im Deutschen Reich). A reprint of the official regulations, in force since April 1, 1905. 1500 w. Elektrotech Zeitschr—April 27, 1905. No. 69770 B.

The Massie Wireless Telegraph System. A. Frederick Collins. Illustrated detailed description. 1800 w. Sci Am Sup—May 20, 1905. No. 69624.

Wireless Telegraphy in Germany. A. Frederick Collins. Information from a pamphlet written by Count Arco in regard to the System Telefunken, as the combined systems are called. 2800 w. Elec Wld & Engr—May 27, 1905. No. 69918.

Space Telephony.

High Frequency Currents and Space Telephony (Les Courants de Haute Fréquence et la Téléphonie sans Fil). L. Ancel. An examination of the phenomena of high frequency currents, and a discussion of the Ruhmer system of telephony by the action of light on selenium. 4000 w. Mem Soc Ing Civ de France—Feb., 1905. No. 69785 G.

Telephone Cables.

Comparative Investigations of System Cables (Vergleichende Untersuchungen an Systemkabeln). Dr. W. Schuler. An examination of the special cables used in the interior of a telephone exchange, as distinguished from line cables. 7000 w. Elektrotech Zeitschr—May 4, 1905. No. 69771 B.

Telephones.

British-Made Telephones. An illustrated account of a visit to the General Electric Company's Salford works. 3000 w. Elec Engr, Lond—May 12, 1905. No. 69822 A.

Telephony.

The Telephone System of To-day. C. J. H. Woodbury. Abstract of a paper before the Brooklyn Inst. of Arts & Sciences. An explanation of the latest type of the telephone system, discussing operation, rates, &c. 4500 w. Elec Rev, N Y—May 13, 1905. No. 69528.

DISTRIBUTION.

Accumulators.

Switch Connections for Storage Battery Plants (Ueber Leitungen Sparende Zellenschalter für Akkumulatorenbatterien). C. Liebenow. Describing switch connections for a storage battery by which the cells may be thrown into service in various combinations. 2500 w. Elektrotech Zeitschr—May 4, 1904. No. 69773 B.

Cables.

Types of Electric Cables: Hints on Their Manipulation. J. H. C. Brooking. Notes applying more particularly to paper-insulated cables, and the troubles when used under bad conditions. 2800 w. Prac Engr—May 5, 1905. No. 69582 A.

Conduit System.

Underground Electrical Conduit System in New Orleans. Illustrates and describes this work nearing completion, which required unusual care because of the character of the soil, the drainage system and climatic conditions. 1500 w. Elec Wld & Engr—May 13, 1905. No. 69566.

We supply copies of these articles. See page 638.

Current Losses.

Theft of Current: How to Detect, Prosecute and Prevent. J. H. Hallberg. A description of methods successfully employed, with references to specific cases of theft current. Ills. 2200 w. Elec Wld & Engr—April 29, 1905. Serial. 1st part. No. 69315.

Fuses.

Low-Tension Fuses. Prof. Alfred Schwartz and W. H. N. James. Abstract of a paper on "Low Tension Thermal Cut-outs," read before the Manchester Loc. Sec. of the Inst. of Elec. Engrs. A report of experimental investigations. 5000 w. Elect'n, Lond—April 21, 1905. No. 69333 A.

Relays.

Time-Limit Relays. George F. Chellis. Discusses the operation of various types. 3200 w. Am Inst of Elec Engrs—May, 1905. No. 69688 D.

Switches.

Automatic High Pressure Switches (Automatischer Hochspannungsschalter). Max Vogelsang. Describing a form of oil insulated switch adapted for automatic parallel operation. 4000 w. Elektrotech Zeitschr—May 11, 1905. No. 69775 B.

ELECTRO-CHEMISTRY.

Alkalies.

Progress in the Electrolytic Alkali and Bleach Industry. John B. C. Kershaw. Notes in regard to the position of the industry in the various countries. 1800 w. Elec Rev, N Y—May 27, 1905. No. 69901.

Battery.

A Novel Thermo-Electric Battery. Emile Guarini. Illustration, with brief description, of a battery called a "thermotor," made in Germany. 500 w. Sci Am Sup—May 6, 1905. No. 69393.

Electric Furnaces.

The Present Status of Electric Furnace Working. Charles F. Burgess. States some of its advantages, illustrating and describing various forms, furnace construction, &c., and discussing its efficiency. General discussion. 10500 w. Jour W Soc of Engrs—April, 1905. No. 69685 D.

Electric Smelting.

Operative Results of Some Electric Iron and Steel Processes (Betriebsergebnisse einiger Elektrischer Eisen und Stahlprozesse). Dr. B. Neumann. Data and results of work with the Héroult, Keller, Stassano, and Kjellin furnaces. 3500 w. Stahl und Eisen—May 1, 1905. No. 69741 D.

The Electrometallurgy of Iron and Steel (Beiträge zur Elektrometallurgie des Eisens und Stahls). Dr. Albert Neuburger. Discussing the practical working of the processes of Harmet, Girod, Neuburger-Minet, Ruthenburg, and Conley. 3000 w. Glückauf—May 13, 1905. No. 69751 D.

Nitric Acid.

The Electrical Production of Nitric Acid—A Review. H. R. Carveth and C. L. Rand. A review of methods of investigators and of work up to the present time. 4000 w. Sib Jour of Engng—May, 1905. No. 69659 C.

ELECTRO-PHYSICS.

Conductivity.

The Effect of Impurities on the Electrical Conductivity of Copper. Lawrence Addicks. Gives results of experiments made with the idea of determining the amount of various elements which would lower the conductivity 3 or 4 per cent. 1500 w. Am Inst of Min Engrs—Feb., 1905. No. 69846.

Insulation.

Considerations Relating to the Design of the Armature Slot Insulation in High Voltage Alternating Current Generators. H. M. Hobart. Investigations as regards the thickness of the slot insulation from the armature conductors to the iron core are discussed in the present article. 900 w. Elec Rev, Lond—April 28, 1905. Serial. 1st part. No. 69471 A.

Magnetism.

Notes on the Effect of Electric Oscillations on Magnetism. L. H. Walter. Notes relating to magnetic detectors, based upon experimental work. Reference is also made to work of other investigators. 1800 w. Elect'n, Lond—May 5, 1905. No. 69590 A.

Magnets.

A Comparison of Common Methods of Magnet Coil Winding. Charles R. Underhill. 1400 w. Am Elect'n—May, 1905. No. 69359.

The Law of the Plunger Electromagnet. Charles R. Underhill. Showing that the formula given by Prof. Sylvanus P. Thompson is not strictly correct when applied to this type. 1000 w. Elec Wld & Engr—May 20, 1905. No. 69672.

Radioactivity.

Radium and Radioactivity (Le Radium et la Radioactivité). Paul Besson. A description of the preparation of radium salts, and a review of the investigations which have been made during the past two years. 10000 w. Mem Soc Ing Civ de France—Feb., 1905. No. 69784 G.

Rotation.

An Investigation of Rotations Produced by Current from a Single-Phase Alter-

nator. Arthur Curtis Scott. Correlation of experimental data, facts and theories, with verification of principles evolved, and a general study of the subject. Ills. 30000 w. Bul Univ of Wis—No. 102—Sept., 1904. No. 69615 D.

Solenoids.

Calculation of Pull Due to Solenoids. Charles R. Underhill. Gives data obtained by tests, and applies these data to practical design. 1800 w. Elec Wld & Engr—May 13, 1905. No. 69567.

The Practical Design of the Solenoid. Charles R. Underhill. Discusses the law controlling the action when a current is passed through the winding. 1200 w. Elec Wld & Engr—April 29, 1905. No. 69316.

Sparking.

Limits of Injurious Sparking in Direct-Current Commutation. Thorburn Reid. Considers in detail what happens to a commutator segment while the machine is running, and aims to prove that the question of sparking is simply a question of the temperature of the segment while it is under the brush. 7200 w. Am Inst of Elec Engrs—May, 1905. No. 69691 D.

The Influence of the Ionized Medium and the Resistance upon Sparks over Wide Gaps (Beeinflussung Grosser Funkenstrecken durch Ionisierende Körper und der Uebergangswiderstand). Dr. W. Voege. An examination of the law governing electrical discharges, with especial reference to the influence of the intervening medium. 3000 w. Elektrotech Zeitschr—April 20, 1905. No. 69765 B.

GENERATING STATIONS.

Dynamo.

A New Dynamo. From *Elektrotechnische Zeitschrift.* Illustrates and describes a dynamo designed by Prof. E. Rosenberg for the lighting of railway carriages. 2400 w. Elec Engr, Lond—April 28, 1905. No. 69469 A.

Dynamo Testing.

See Electrical Engineering, Measurement.

Erection.

Installing Electric Machinery. Norman G. Meade. Gives a few practical hints for erecting such apparatus, with illustrations. Power—May, 1905. No. 69420 C.

Hydro-Electric.

A Norwegian Hydro-Electric Plant. T. Norberg Schulz. Gives calculations made with the intention of solving the economical problems raised in connection with the combined operation of an older steam station and newer water power plant. 1000 w. Elec Wld & Engr—April 29, 1905. No. 69314.

Hydraulic Station, La Goule, Switzerland. F. M. Bryan. Illustrated description of a power transmission plant having many unusual features. It was designed to supply many small motors over quite an extensive territory. Also editorial. 2800 w. Elec Wld & Engr—May 20, 1905. No. 69671.

The Hydraulic Plant of the Puget Sound Power Company. Edwin H. Warner. Illustrated description of this power plant in Washington, which will supply power to Seattle, Tacoma, and interurban railways. 6000 w. Pro Am Soc of Civ Engrs—May, 1905. No. 69878 E.

The Hydraulic Power Works on the River Glommen, Norway. An interesting account of one of the largest hydraulic power works in Europe for the generation of electrical energy. Ills. 1300 w. Sci Am Sup—May 20, 1905. Serial. 1st part. No. 69623.

The Necaxa Plant of the Mexican Light & Power Co. J. L. Bothwell. Short description of a plant of unusual engineering interest. 1200 w. Eng Rec—May 20, 1905. No. 69811.

The New Hydro-Electric Power Plant of Cornell University. W. W. Churchill. An illustrated article giving a full account of this work and describing the design and construction. 3500 w. Eng Rec—May 20, 1905. No. 69804.

The Supply of Electric Energy to Burgos (Transporte de Energia Electrica á Burgos). A description of the proposed hydro-electric plant on the Ebro, 50 kilometres from Burgos, Spain, for the generation and transmission of 1,100 h. p. for power and lighting. Serial. Part I. 7000 w. Revista de Obras Publicas—April 27, 1905. No. 69787 D.

Isolated Plant.

Power Plant of the First National Bank Building, Chicago. An illustrated detailed description of a fine isolated plant that supplies power for a 17-story building. 3800 w. Engr, U S A—May 1, 1905. No. 69361 C.

The Power Installation at the Whittall Mills. Howard S. Knowlton. Illustrates and describes an interesting steam and electric installation recently placed in operation in some carpet mills in Worcester, Mass. 2500 w. Eng Rec—May 6, 1905. No. 69448.

Municipal Plant.

Municipal Light and Power in Tacoma, Wash. Howard Joslyn. Abstract of a paper read before the Pacific N. W. Soc. of Engrs. A full account of cost and earnings since the purchase of the plant in 1893, and the arrangements that have made possible the exceedingly low rates of the past two years. 2800 w. Elec Rev, N Y—May 13, 1905. No. 69529.

We supply copies of these articles. See page 638.

Operation.

Incidents in the Operation of a Large Power Plant and Distribution System. H. G. Stott. Gives incidents which occurred in the 74th St. plant and transmission system of the Interborough Rapid Transit Co. of New York City. 1500 w. Elec Club Jour—May, 1905. No. 69663.

Reserve.

Duplication of Electrical Apparatus to Secure Reliability of Service. H. W. Buck. Discusses the question of the proper reserve in an electrical installation, considering the several classes of apparatus and their liability to injury. 2500 w. Am Inst of Elec Engrs—May, 1905. No. 69689 D.

Santa Cruz, Cal.

Electricity in the "City of the Holy Cross." An illustrated article describing the electrical situation, the service being divided among six different companies. 4400 w. Jour of Elec—May, 1905. No. 69564 C.

Turbo-Alternator.

2,700 Horse-Power Turbo-Alternator. Illustrated description of a powerful combined set made in Switzerland. 2000 w. Engr, Lond—April 21, 1905. No. 69342 A.

LIGHTING.

Decoration.

Decorative Insulating Beads for Uninsulated Electric Light Wires. Illustrates and describes a system in which beads of cut and polished glass are strung on naked wires of copper, stating the advantages. 900 w. Sci Am Sup—May 20, 1905. No. 69625.

Fittings.

Fittings. Harold Watson. Abstract of a paper read before the Glasgow Loc. Sec. of the Inst. of Elec. Engrs. An illustrated article considering some of the factors in the evolution of the design of electric fittings, and some of the conditions designers have to fulfil. 3300 w. Elect'n, Lond—May 12, 1905. No. 69821 A.

Illumination.

Lighting an Assembly Room. W. H. Wakeman. Illustrated description of a plan adopted for controlling lights in the assembly room of a large school building. 700 w. Elec, N Y—May 17, 1905. Serial. 1st part. No. 69605.

Lamps.

Is the Carbon Filament Lamp Doomed? E. Leavenworth Elliott. A brief review of the carbon filament lamp, discussing the merits and demerits of the lamps aiming to improve upon it. 3500 w. Cent Sta—May, 1905. No. 69484.

New American Lamps (Neue Amerikanische Lampen). Clarence Feldmann. Discussing especially the mercury vapor lamp, and the American forms of the Nernst lamp. 2000 w. Elektrotech Zeitschr—May 11, 1905. No. 69776 B.

Lighthouses.

The Electric Illumination of Lighthouses. Editorial discussion of English and French practice, and the suitability of electric illumination. 1200 w. Engr, Lond—May 5, 1905. No. 69600 A.

Nernst.

Street Lighting in New England. Illustrates and describes the successful adaptation of Nernst lamps at West Hartford, Conn. 1000 w. Elec Rev, N Y—May 20, 1905. No. 69670.

Paris.

The Electric Lighting Situation in Paris. Begins a review of the report of a technical commission appointed to investigate the problem. Map. 1000 w. Elec Wld & Engr—May 13, 1905. Serial. 1st part. No. 69568.

Photometry.

See Electrical Engineering, Measurement.

Tantalum.

Measurements upon the Tantalum Lamp (Messungen an Tantallampen). Egon Siedek. With diagrams of comparative measurements with the carbon filament showing the superiority of the tantalum lamp. 1000 w. Zeitschr f Elektrotechnik—May 7, 1905. No. 69780 D.

Train Lighting.

See Railway Engineering, Motive Power and Equipment.

MEASUREMENT.

Alternator Curves.

The Analysis of Alternator Curves. Charles F. Smith. Explains the method of curve analysis, illustrating by example. 1700 w. Mech Engr—May 13, 1905. Serial. 1st part. No. 69819 A.

Dynamo Testing.

A New Method of Testing Alternators (Eine Neue Methode zur Prüfung von Wechselstromgeneratoren). H. M. Hobart and F. Punga. The losses are separated into friction losses, heating, and iron losses. 2000 w. Elektrotech Zeitschr—May 11, 1905. No. 69774 B.

Some Advantages of Liberal Design. B. G. Lamme. Comments upon the "Test of a 5,000 Kw. Alternator." 800 w. Elec Club Jour—May, 1905. No. 69664.

Test of a 5,000 Kw. Alternator. L. L. Gaillard. An illustrated general description of the series of tests made on each of the alternators installed in the 74th St. station of the Interborough Rapid Transit Co., of New York City. 1800 w. Elec Club Jour—May, 1905. No. 69662.

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Harmonic Analysis.

Harmonic Analysis Reduced to Simplicity. Silvanus P. Thompson. A description of a new rapid method of harmonic analysis. 2800 w. Elect'n, Lond—May 5, 1905. No. 69588 A.

Magnetic Testing.

Comparative Magnetic Researches with the Iron-Testing Apparatus of Epstein, Möllinger, and Richter (Vergleichende Magnetische Untersuchungen mit den Eisenprüfapparaten von Epstein, Möllinger und Richter). E. Gumlich and P. Rose. A very full account of investigations upon hysteresis conducted at the Reichsanstalt. 8000 w. Elektrotech Zeitschr—April 27, 1905. No. 69768 B.

Mirror Instruments.

An Extension of the Poggendorff Mirror-Reading Method (Eine Erweiterung der Poggendorffschen Spiegelablesungsmethode). E. Preuss. Describing a method of multiplying the movement of the spot of light, for galvanometers and similar reflecting instruments. 2000 w. Elektrotech Zeitschr—April 27, 1905. No. 69769 B.

Motor Testing.

The Eddy Current Brake for Testing Motors. D. K. Morris, and G. A. Lister. Abstract of a paper read before the Birmingham Sec. of the Inst. of Elec. Engrs. States the advantages of eddy current brakes, and describes a new design. Ills. 1800 w. Mech Engr—April 29, 1905. No. 69466 A.

Oscillograph.

A Convenient Form of Oscillograph. F. A. Laws. Illustrated description of a form of oscillograph which has been developed in the Massachusetts Institute of Technology to meet the requirements of students in the laboratory. 1800 w. Elec Wld & Engr—May 6, 1905. No. 69427.

Photometry.

Photometric Tests of Street Lamps in Teddington. Clifford C. Paterson. Gives results of some photometric measurements of street lamps, with data concerning the amount of gas and electricity taken by the lamps under test. 700 w. Elect'n, Lond—April 28, 1905. No. 69473 A.

Synchronizer.

The Automatic Synchronizer. Norman G. Meade. Illustrates and describes the instrument and its operation, and also other synchronizing devices. 1700 w. Elec Club Jour—May, 1905. No. 69665.

Wattmeter.

The Westinghouse Direct-Current Integrating Wattmeter. Illustrations with description. 600 w. Sci Am Sup—May 13, 1905. No. 69490.

MOTORS.

Alternating Current.

The Alternating-Current Series Motor. F. Creedy. An account of some investigations carried out at the Central Technical College between March and July, 1904, which are intended to show the effect, on the performance of the motor, of varying the elements of the design. 12800 w. Inst of Elec Engrs—April 13, 1905. No. 69331 D.

Commutation.

Commutation in a Four-Pole Motor. J. K. Catterson-Smith. A report of investigations with a view to recording by means of the oscillograph the actual manner in which the current is reversed during commutation, giving results. 2000 w. Inst of Elec Engrs—March 15, 1905. No. 69330 D.

Induction Motors.

Notes on the Theory and Testing of the Polyphase Induction Motor. W. Rogers. Describes the polyphase induction motor and considers some methods of starting and regulating the speed, in the present number. 3500 w. Elec Engr, Lond—May 12, 1905. Serial. 1st part. No. 69824 A.

Motor Controllers.

Automatic Controller for Induction Motors. William Main. Illustrates and describes a motor controller for a three-phase sixty-cycle General Electric induction motor. 800 w. Am Mach—Vol. 28, No. 20. No. 69617.

The Design of Controllers with Shifting Contacts (Ueber den Entwurf von Kontrollern mit Wanderkontakten). Robert Edler. Describing the design of special forms of controllers for use with electric cranes. 3000 w. Zeitschr f Elektrotechnik—May 7, 1905. No. 69779 D.

Motor Testing.

See Electrical Engineering, Measurement.

Single Phase.

The Computations for Single-Phase Commutator Motors (Zur Berechnung Einphasiger Kommutatormotoren). J. K. Sumec. A mathematical examination of the theory of the various forms of single-phase motors, with applications to practical details of design. 6000 w. Zeitschr f Elektrotechnik—April 23, 1905. No. 69777 D.

TRANSMISSION.

High Pressure.

Discussion on "Line Construction for High-Pressure Electric Railroads," and "High-Pressure Line Construction for Alternating-Current Railways." Discussion on papers of Mr. Varney and Mr. Damon. Ills. 5600 w. Am Inst of Elec Engrs—May, 1905. No. 69690 D.

We supply copies of these articles. See page 638.

Line Losses.

Line Effects Due to a Moving Load. Carl P. Nachod. An analytical study of the distribution of current potential and energy lost in circuits supplying power from two points to a locomotive traversing the distance between them. Also editorial. 900 w. Elec Wld & Engr—April 29, 1905. No. 69317.

Poles.

The Deflection of Pole Supports for Line Wires (Durchbiegung von Leitungsmasten). K. Otto. Discussing especially the stiffness of latticed poles and masts and their resistance to deflection; deriving a formula for taper masts. 1500 w. Elektrotech Zeitschr—April 20, 1905. No. 69764 B.

Relays.

Relays for Direct and Alternating Current Circuits. An illustrated description of a series of direct and alternating current relays manufactured by the British Westinghouse Company. 1700 w. Elec Engr, Lond—May 5, 1905. No. 69586 A.

MISCELLANY.

Exhibition.

Report upon the Exhibition of the Electrotechnical Society (Bericht über die Ausstellung des Electrotechnischen Vereins). F. Breisig. A fully illustrated description of the principal exhibits of the electrical exposition held on the twenty-fifth anniversary of the society. 25000 w. Elektrotech Zeitschr—April 20, 1905. No. 69766 B.

Hippodrome.

The Application of Electricity in the New York Hippodrome. An illustrated article describing some of the novel features of the stage and the applications made of electricity for handling scenery, regulating lights, &c., in this large amusement building. 2500 w. Elec Rev, N Y—April 29, 1905. No. 69276.

Lightning.

Report of the Lightning Research Committee. Sir Oliver Lodge gives a preface explaining the report, which follows. 6300 w. Jour Ry Inst of Brit Archts—May 6, 1905. No. 69899 D.

INDUSTRIAL ECONOMY

Address.

Presidential Address at the Annual Meeting in London, of the Iron & Steel Institute. R. A. Hadfield. Reviews the history of the manufacture of iron and steel. 21000 w. Ir & Coal Trds Rev—May 12, 1905. No. 69883 A.

Presidential Address Delivered Before the Iron and Steel Institute. R. A. Hadfield. Abstract of address delivered May 11, 1905. A history of iron and steel manufacture. 8000 w. Engng—May 12, 1905. No. 69831 A.

Presidential Address to the Institution of Mechanical Engineers. Edward P. Martin. On some of the improvements applied to the manufacture of iron and steel which have greatly increased the output and reduced the cost of production. 6500 w. Engr, Lond—April 21, 1905. No. 69348 A.

Canada.

The Canadian Dominion of To-day: Its Industries, Commerce, Railways and Waterways. An interesting general review. Ills. 19500 w. Ir & Coal Trds Rev—May 12, 1905. No. 69894 A.

Commerce.

The Commerce of the United States. Reviews a recent report issued by the Treasury Department at Washington on the foreign commerce and home trade, showing the rapid growth of industries. 2300 w. Engng—April 28, 1905. No. 69475 A.

Education.

American Technical Laboratories (Amerikanische Technische Laboratorien). A. Gramberg. A description from a German viewpoint of the mechanical laboratories of the principal engineering schools in America. 4500 w. Zeitschr d Ver Deutscher Ing—April 22, 1905. No. 69705 D.

The Function of Laboratory Courses in the Curriculum of Engineering Schools. Charles Edward Lucke. Discusses the methods of laboratory instruction, the aim, &c. 4700 w. Trans Am Soc of Mech Engrs, No. 066—June, 1905. No. 69553 C.

Exports.

Engineering Exports of Britain, Germany and the United States. W. Pollard Digby. A review of the general industrial situation, showing the trend of trade supremacy. 3000 w. Engineering Magazine—June, 1905. No. 69791 B.

Labor.

Labor, Foreign Commerce, and Railroad Questions. D. M. Parry. Extracts from the Presidential Address at the convention of the Nat. Assn. of Mfrs. Discusses the questions of labor, interstate commerce legislation, rates, &c. 5000 w. Ir Age—May 18, 1905. No. 69610.

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MARINE AND NAVAL ENGINEERING

Arctic Ship.

Peary's Arctic Exploration Ship. An illustrated detailed description of the "Roosevelt." 5400 w. Marine Rev—May 4, 1905. No. 69438.

Peary's Latest Arctic Ship, the Roosevelt. Illustrated description of this vessel, giving design plans. It is technically described as a "three-masted, fore-and-aft, schooner-rigged steam vessel, with auxiliary sail power." It has features of unusual interest to meet the severe requirements. 2000 w. Marine Engng—May, 1905. No. 69297 C.

Armor Plate.

Armor Plate and Projectile Trials. Gives illustrations and report of results of trials to show the resistance qualities of the latest type of armor forming the belt of the Japanese Battleship No. 1, now being built. 1200 w. Engng—April 28, 1905. No. 69477 A.

Boilers.

See Mechanical Engineering, Steam Engineering.

Car-Ferry.

Car-Ferry Steamer "Detroit"; Michigan Central R. R. Illustrates and describes a four-screw car-ferry steamer of exceptional size and power, designed to serve as an ice-breaker and to maintain service between Detroit, Mich., and Windsor, Ont. 1000 w. Eng News—May 4, 1905. No. 69363.

Cruisers.

The Japanese Cruisers "Kasuga" and "Nisshin." Col. N. Soliani. A very complete illustrated description of details of construction. 5000 w. Engng—April 21, 1905. No. 69335 A.

The Machinery of the Armored Cruisers North Carolina and Montana. Illustrated description of the machinery. 1700 w. Marine Engng—May, 1905. No. 69296 C.

The Steam Trials of H. M. SS. "Antrim" and "Devonshire." Illustrations, report of trials, and remarks on features of interest. 1500 w. Engng—April 28, 1905. No. 69480 A.

Destroyers.

Some Notes and Recollections of Destroyer Trials. Illustrates a number of these vessels, and gives an account of the preparation for the trials, the work of the men during the trial, &c. 2800 w. Marine Rev—May 11, 1905. No. 69532.

The Development of the Torpedo-Boat Destroyer. W. J. Harding. Abstract of a paper read before the Inst. of Marine Engrs. An interesting review, with illustrations. 6900 w. Naut Gaz—May 25, 1905. No. 69897.

Gas Power.

See Mechanical Engineering, Combustion Motors.

Gyrostats.

Gyrostats and Gyrostatic Action. Prof. Andrew Gray. Describes examples of gyrostatic action, and discusses the fundamental principles and their explanation, and related subjects, considering various devices and the action of steamers in which the main propelling engines are of the steam turbine type. 15000 w. Ills. Trans Inst of Engrs & Shipbldrs in Scotland—March 21, 1905. No. 69640 D.

Some Notes on the Effects Likely to Be Produced by the Gyroscopic Action of Steam Turbines on Board Vessels Pitching in a Sea. J. Blacklock Henderson. An examination of possible effects. 1200 w. Trans Inst of Engrs & Shipbldrs in Scotland—March 21, 1905. No. 69639 D.

Ice Breaker.

Ice Breaker for the Delaware. Illustrated description of vessel to be built for the city of Philadelphia for use on the Delaware. 1800 w. Marine Rev—May 4, 1905. No. 69439.

Launches.

A Novel Power Launch for Clearing Weed-Infested Waterways. Illustrates and describes a motor launch equipped with a novel cutting appliance—the Saunderson gasoline power weed - cutting launch. 900 w. Sci Am—May 27, 1905. No. 69868.

French Launches and Launch Engines of 1905. W. P. Stephens. An illustrated article describing interesting features, and types, and commenting on the remarkable development of the launch industry. 2000 w. Rudder—May, 1905. No. 69373 C.

Marine Designs.

Factors of Safety in Marine Designs. A. E. Seaton. Read before the Inst. of Naval Archts. Discusses the margins now imposed, especially on boilers, and the evils and cost of the present way of insuring satisfactory performance. 4000 w. Engng—April 28, 1905. No. 69482 A.

Model Experiments.

Model Experiments on Hollow *versus* Straight Lines. R. E. Froude. Read be-

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fore the Inst. of Naval Archts. Describes the special apparatus and mode of experiment employed. 5800 w. Engng—April 21, 1905. No. 69339 A.

Motor Boats.

Light-Draft Gasolene-Propelled Western River Boat. Brief illustrated description of the sternwheeler City of Fort Pierre, operating on the Upper Missouri River. It is equipped with an 80 h. p. Otto engine. 500 w. Naut Gaz—May 4, 1905. No. 69437.

Motor Boats at Monaco. Begins a review of the racing boats, discussing their design and construction. 2200 w. Engr, Lond—April 21, 1905. Serial. 1st part. No. 69345 A.

Notes on Power-Boat Design. N. L. Skene. A discussion of some of the important features of their design, such as form, especially of the underbody, outlining a practical method. 2200 w. Rudder —May, 1905. No. 69375 C.

Paddle Steamers.

Thames Paddle-Steamer for the London County Council. Brief illustrated description of one of two recently launched steel vessels. 200 w. Engng—May 5, 1905. No. 69594 A.

Repairs.

Electrical Repairs at Sea. Describes some of the methods of testing and makeshifts resorted to where conditions are often very different from those on land, and supplies not always available. 2400 w. Elec Rev, Lond—April 28, 1905. No. 69470 A.

Resistance.

The Effect of Acceleration on Ship Resistance. C. E. Stromeyer. Read before the Inst. of Naval Archts. Notes on Beaufoy's experiments, with explanation of an attempt to obtain resistance curves of ships and applying the method to Beaufoy's work. 2000 w. Engng—April 21, 1905. No. 69340 A.

Russian Fleet.

The Russian Volunteer Fleet. Herbert Rowell. Read before the Inst. of Naval Archts. The present article explains the objects of the Russian Volunteer Fleet Assn. and describes the ships. Ills. 3500 w. Engng—April 28, 1905. Serial. 1st part. No. 69481 A.

Shipbuilding.

Steel Ship Building Berths. F. H. Rudolph. Illustrates and describes the steel ship-building slips at Vulcan plant at Stettin. 1600 w. Marine Rev—May 4, 1905. No. 69440.

Steamer.

Twin-Screw Passenger and Cargo Steamer. Illustrations and description of the shallow draught steamer "Naparima," and her machinery. This vessel is to be run in conjunction with the Trinidad Government Railways. 1600 w. Engng—April 28, 1905. No. 69476 A.

Steering.

Electric Steering. George E. Walsh. Information concerning the development of steering devices to be operated by electricity, and the fields where it has been successfully applied. 2000 w. Marine Engng—May, 1905. No. 69301 C.

Training Ship.

The Training of Sailors. Illustrated description of a recently launched vessel specially designed for the training of boys for the naval and merchant marine. 1700 w. Engng—April 21, 1905. No. 69337 A.

Turkish Fleet.

The Reconstruction of the Turkish Fleet. Dagnino Attilio. Some information in regard to the rebuilding of the largest ship in the Turkish navy, the *Mess'oudijeh*, and the construction of torpedo boats. Ills. 1400 w. Marine Engng —May, 1905. No. 69300 C.

War Ships.

The Principle of the Cellular Construction of Ships (Note sur le Principe des Navires à Flottaison Cellulaire). M. Bertin. A review of the extension of the applications of the cellular system since the writer's first communication to the Academy in 1884. 1800 w. Comptes Rendus—April 17, 1905. No. 69723 D.

Yachts.

The Stability Calculation for a Modern Sailing Yacht. Gives method, describing the operations. Diagrams. 2000 w. Marine Engng—May, 1905. No. 69298 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air Cooling.

The Problem of Air Cooling. F. Reaugh. Considers some of the difficulties in the way of air-cooling and some possible ways of surmounting them. 1800 w. Automobile—April 29, 1905. No. 69273.

Car Control.

Car Control by Spark and Throttle. Considers the various manipulations best suited to different types of cars. 2500 w. Automobiles—April 29, 1905. No. 69274.

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Cupelle.

The Cupelle Petrol Cars. An illustrated article giving particulars of these cars. 1100 w. Auto Jour—May 6, 1905. No. 69579 A.

Drives.

Points on Propeller Shaft Drive. Rene M. Petard. Gives some details concerning chain driven, and Cardan shaft transmission, showing that the latter can be made as flexible as the chain. 1300 w. Automobile—May 13, 1905. No. 69530.

Dust Laying.

Dust-Laying Experiments at Liverpool. A. Lyle Rathbone. From a paper read before the Liverpool Self-propelled Traffic Assn. On the experiments of a temporary and also of a more or less permanent character, made in Liverpool during the past three or four years. 2400 w. Autocar—April 29, 1905. No. 69463 A.

Industrial Vehicles.

Motor Vehicles for Industrial Use on Streets without Tracks (Motorisch Betriebene Fahrzeuge auf Schienenlosen Strassen für Industrielle Zwecke). Karl Rubricius. Illustrating numerous types of industrial vehicles with data concerning their performance. 3500 w. 2 plates. Oesterr Wochenschr f d Oeffent Baudienst—May 6, 1905. No. 69763 D.

Five-Wheeled.

A Novel Five-Wheeled Automobile. Illustrates and describes a vehicle propelled by a drum-like fifth wheel under its center. 700 w. Sci Am—May 13, 1905. No. 69488.

Garage.

New Electric Garage in Denver. Illustrated description of a new garage for the handling and storage of electric automobiles. 900 w. Elec Wld & Engr—May 27, 1905. No. 69919.

Locomotion.

Some Problems of the Automobile. Frederic Remsen Hutton. A simple discussion of fundamental principles of car and motor design in locomotion on the highways. 1800 w. Automobile—May 6, 1905. Serial. 1st part. No. 69394.

Petrol Cars.

Petrol Motor Cars. Frank Little. An illustrated article, describing the details of a petrol car and the working, and discussing many designs and types. 12000 w. Trans N E Coast Inst of Engrs & Shipbldrs—April, 1905. No. 69638 E.

The Métallurgique Petrol Cars. Illustrates and describes the interesting features of these cars. 1100 w. Auto Jour —May 13, 1905. No. 69814 A.

Pivot.

The 1905 Pivot Cars. Illustrated description of this French car. 600 w. Auto Jour—April 22, 1905. No. 69325 A.

Racer.

Mr. Lionel de Rothschild's Siddeley Racer. Illustrated detailed description of a fine example of automobile design and construction. The car is entered for the Gordon-Bennett race. 1800 w. Auto Jour—April 29, 1905. No. 69461 A.

Simms-Welbeck.

The Simms-Welbeck Cars. Drawings and description showing the general design of three types of automobiles constructed by this company. 1000 w. Autocar—May 13, 1905. No. 69699 A.

Touring Car.

Peerless 35-Horsepower Touring Car. Illustrated detailed description. 2800 w. Automobile—April 29, 1905. No. 69275.

Stevens-Duryea 20-Horse-power Touring Car. Illustrated description. 1000 w. Automobile—May 18, 1905. No. 69649.

Studebaker 20-Horsepower Touring Car. Illustrated detailed description of a car built in South Bend, Ind. 2200 w. Automobile—May 25, 1905. No. 69872.

The 20 H. P. Legros & Knowles Touring Car. Description and diagrams of an English made car. 900 w. Autocar—April 22, 1905. No. 69326 A.

COMBUSTION MOTORS.

Alcohol.

A Comparative Technical Study of Denaturized Alcohols (Etude Technique Comparative des Alcools Dénaturés). Lucien Périssé. A report of the tests upon the internal-combustion motors at the Vienna exhibitionn of 1904, using alcohol as fuel. Methods of denaturizing are given. 10000 w. Mem Soc Ing Civ de France—Feb., 1905. No. 69786 G.

Carburetters.

Carburetters. Abstract of a lecture by Mr. Mervyn O'Gorman before the Auto. & Cycle Engrs.' Inst. A study of the requirements, what has already been accomplished, and how to get the best results. 4000 w. Autocar—April 22, 1905. Serial. 1st part. No. 69462 A.

Diesel.

The Diesel Engine. W. H. Booth. Reports results of a test recently carried out on a Diesel engine of 150 b. h. p. 2800 w. Elec Mag—April 25, 1905. No. 69613 C.

Explosion Engines.

The Working of a Large Compound Explosive Engine on Petrol or Benzoline Spirit. E. Butler. A report of some experiments and tests made by the writer. 1000 w. Mech Engr—May 6, 1905. No. 69583 A.

Gas Engines.

Recent Gas and Oil Engine Develop-

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ments. Thomas Holgate, in *Technics*. Reports the development as shown by engines exhibited at Earl's Court, giving illustrations. 3300 w. Sci Am Sup—May 13, 1905. No. 69491.

The Mechanical Efficiency of the Gas Engine. W. H. Booth. An explanation of the losses that occur and their cause, and a comparison with steam engine efficiency. 1500 w. Power—May, 1905. No. 69415 C.

Gasolene Engines.

Fuel Mixing Devices for Gasolene Engines. E. W. Roberts. Considers various types of carburetors, vaporizers, mixing valves, and generator valves, giving illustrations. 3800 w. Rudder—May, 1905. No. 69376 C.

Testing for Horse-Power and Fuel Consumption. A. E. Potter. Describes methods of testing gasolene engines. 3300 w. Rudder—May, 1905. No. 69374 C.

Gas-Producers.

Gas-Producer Power-Plants. Samuel S. Wyer. Gives facts relating to the design, operation and maintenance of gas-producer plants showing their advantages. 3300 w. Am Inst of Min Engrs—Feb., 1905. No. 69844.

Producer Gas Power. H. Williams. Discusses its application for factories, cold stores, &c., in place of steam power, pressure vs. suction gas plants, and comparative cost. 4000 w. Ice & Refrig—May, 1905. No. 69425 C.

The Riche Gas Producer. Dr. A. Gradenwitz. Illustrated description of two systems of gas-producing designed for burning waste wood, shavings and sawdust as well as anthracite coal or coke. 1200 w. Power—May, 1905. No. 69414 C.

The Testing of Gas Producers. Samuel S. Wyer. Description of methods for conducting tests. Also Bibliography of Gas Producers. 5000 w. Am Inst of Min Engrs—Feb., 1905. No. 69845 C.

Gas Turbine.

The Question of the Gas Turbine. Sidney A. Reeve. A review of the conclusions of Dr. Lucke, with especial reference to the mixed gas and steam turbine. 3500 w. Engineering Magazine—June, 1905. No. 69797 B.

Heat Engines.

The Junge Heat Engine System. H. Diederichs. Examines the charges at present laid against the gas engine, and the solutions Mr. Junge offers for overcoming the difficulties. 5700 w. Power—May, 1905. No. 69419 C.

Marine Engines.

Gas Producer and Gas Engine for Marine Use. George E. Walsh. Describes a modern marine producer gas plant, presenting some of its advantages. 1800 w. Marine Rev—May 11, 1905. No. 69531.

Marine Gas Engine. Illustrates and describes the construction proposed by Herr Capitaine, which has worked successfully in an experimental model. 1500 w. Engr, Lond—April 21, 1905. No. 69344 A.

The Gas Engine for Marine Motive Power. Alfred Gradenwitz. Describing successful installations of producers and engines on boats, showing the practical advantages. 3000 w. Engineering Magazine—June, 1905. No. 69793 B.

Petrol Engines.

A Large Petrol Engine. Illustrates a 100-H. P. petrol engine, giving a brief description. 500 w. Engr, Lond—May 12, 1905. No. 69837 A.

Power Gas.

Coal Gas and Its Rivals for Motive Power. Dugald Clerk. A lecture to the N. of Eng. Gas Mgrs.' Assn. Discusses fuel costs for power in England, and advocates a reduction in the price of gas for motive power. Urges the substitution of calorific power instead of illuminating power as the standard for gas manufacture. 5500 w. Jour Gas Lgt—May 2, 1905. No. 69499 A.

Gas as a Motive Power, and Its Relative Cost. W. H. Laurie. An illustrated article aiming to show that the gas engine with a suitable gas producer will generate power at less cost than any other source. 3500 w. Can Soc of Civ Engrs—March 23, 1905. No. 69646 C.

HEATING AND COOLING.

Indirect Heating.

Some Features of Indirect Heating. Konrad Meier. Explains the three systems of indirect heating, and the way of determining the best requirement or capacity of the apparatus. 5000 w. Eng Rec—May 27, 1905. No. 69913.

Refrigeration.

Refrigerating Plants on New United Fruit Company Steamers. Illustrates and describes the plants installed on these vessels fitted for carrying bananas. 2800 w. Marine Engng—May, 1905. No. 69299 C.

Standard Unit of Refrigeration. F. E. Matthews. An explanation of the proposition offered by the writer in which the nominal rating is based on the standard ton of 288,000 British thermal units per day, equivalent to the evaporation of 27 pounds of anhydrous ammonia per hour from the standard condition of 90 degrees liquid into 0 degrees saturated gas. 5700 w. Trans Am Soc of Mech Engrs, No. 067—June, 1905. No. 69554 C.

Shop Heating.

An Improvised Hot-Water Shop Heating System. Describes briefly an inter-

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esting adaptation of a waste steam boiler feed-water heating system to the heating of shops and offices, as outlined by A. A. Maver before the Canadian Ry. Club. 1500 w. Eng Rec—May 13, 1905. No. 69572.

Vacuum Steam Heating.

The Principles of Vacuum Steam Heating. George D. Hoffman. An explanation of how a heating plant may be run economically at less than atmospheric pressure. 2300 w. Dom Engng—May 6, 1905. No. 69398.

HYDRAULICS.

Electric Pumping.

Electrically Driven Pumping Machinery (Elektrisch Betriebene Wasserhaltung). H. Koch. Discussing the applications of electric motors to centrifugal and express reciprocating pumps, with especial reference to mining service. 5000 w. Elektrotech Zeitschr—May 4, 1905. No. 69772 B.

The Operation of Pumps by Electric Motors (Allgemeine Betrachtungen über die Pumpen mit Elektrischem Antrieb). H. Koch. Describing applications of electric motors to centrifugal pumps and to Riedler express pumps for mining service. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—April 15, 1905. No. 69755 D.

Hydro Electric.

See Electrical Engineering, Generating Stations.

Niagara.

Utilizing the Power of the Niagara Rapids. Alton D. Adams. A discussion of the various methods by which a large amount of power may be taken from the Niagara rapids below the Falls. 2500 w. Engineering Magazine—June, 1905. No. 69795 B.

Wheel-Pits and Tunnels for Niagara Power. Alton D. Adams. Illustrated description of pits on both the American and Canadian sides, with information of interest relating to them. 3500 w. Elec Rev, N Y—May 20, 1905. No. 69669.

Pumping.

Some Pumping Data. R. Gilman Brown. Gives figures collected from records kept at the Brunswick mine, Grass Valley, Cal., during the fall and winter of 1903-4. 1500 w. Eng & Min Jour—May 18, 1905. No. 69803.

The Harris System of Pumping with Compressed Air. Elmo G. Harris. Illustrated description of apparatus and principles governing its operation. 1800 w. Mines & Min—May, 1905. No. 69410 C.

Pumps.

A Compact Belt-Driven Pump. Illustrated description of a pump designed by H. F. Dunham for moderate capacities, which combines steam-economy with simplicity of structure and accessibility of parts. 1200 w. Eng News—May 4, 1905. No. 69372.

Some Types of Centrifugal Pumps. William O. Webber. Reviews briefly the development of centrifugal pumping, giving illustrations of types, and especially describing designs of the writer, and the development of the multiple-stage centrifugal pump. 3000 w. Trans Am Soc of Mech Engrs, No. 062—June, 1905. No. 69550 C.

Quebec.

Water-Powers of Quebec. J. C. Langelier. Information concerning some of the many great water-powers. Map. 1400 w. Can Engr—May, 1905. No. 69498.

Stream Flow.

See Civil Engineering, Waterways and Harbors.

Water-Hammer.

Water-Hammer in Pipes. J. Wright Clarke. Explains the meaning of the term and its cause, and the remedy. Ills. 2500 w. Plumb & Dec—May 1, 1905. Serial. 1st part. No. 69577 A.

Water Wheels.

The Buckets of Impulse Wheels (Ueber die Schaufelung des Löffelrades). Rudolf Escher. An examination of the theoretical form for buckets for water wheels of the Pelton impulse type. 2500 w. Schweiz Bauzeitung—April 20, 1905. No. 69732 B.

MACHINE WORKS AND FOUNDRIES.

Air Blast.

Air Blast for the Foundry Cupola. W. H. Carrier. Abstract of a paper read before the Buffalo Found. Assn. Discusses the merits of the fan and of the positive blowers, and their relative efficiency. 1700 w. Ir Age—May 11, 1905. No. 69457.

Casting.

The Relative Advantages of Casting from Above or Below (Guss von Oben—Guss von Unten). A. Messerschmitt. An examination of the influence of the method of pouring upon the strength and quality of the casting. 5000 w. Stahl u Eisen—April 15, 1905. No. 69737 D.

Castings.

The Causes and Remedies for Defects in Castings (Wie Entstehen in der Eisengiesserei Fehlgüsse und wie lassen sie sich Vermeiden). H. Fichtner. A discussion of the influence of methods of moulding, gating, venting, etc., upon the soundness of castings. 2000 w. Zeitschr d Ver Deutscher Ing—April 15, 1905. No. 69704 D.

Chains.

Modern Methods of Manufacturing Welded Chain. Leslie B. Powell. Describes the old method of manufacture and the present method, illustrating the three important labor-saving machines used. 1700 w. Am Mach—Vol. 28, No. 19. No. 69501.

Clutch.

A New Form of Friction Clutch. Emile Guarini. Illustrated description of the Hele-Shaw clutch and some of its applications. 800 w. Sci Am Sup—May 20, 1905. No. 69626.

Dies.

Dies for Making and Driving Double-Pointed Tacks. S. A. Worcester. Illustrated description. 700 w. Am Mach—Vol. 28, No. 19. No. 69504.

Drill Grinder.

An Improved Grinding Machine for Twist Drills (Neue Schleifmaschine für Lochbohrer). Hermann Fischer. With numerous diagrams showing the manner in which the drill is held and presented to the emery wheel. 1000 w. Zeitschr d Ver Deutscher Ing—April 29, 1905. No. 69710 D.

Electric Driving.

A Modern Electrically-Driven Manufacturing Plant. Illustrated description of the Ingersoll-Sergeant Drill Company's new works at Phillipsburg, N. J. 1400 w. Am Elect'n—May, 1905. No. 69357.

Electric Driving for Iron Works (Die Elektrische Kraftübertragung auf Hüttenwerken). F. Janssen. A discussion of the advantages of electric power for iron works, with plans for a complete power plant. Serial. Part I. 5000 w. Stahl u Eisen—May 1, 1905. No. 69738 D.

Electric Motor Application. Ernest G. Howard. Extracts from a paper read before the Connecticut Valley Metal Trades Assn. An account of the equipment for the shops of the Chapman Valve Mfg. Co. 2000 w. Ir Trd Rev—May 11, 1905. No. 69500.

Electric Power in Steel Works. Illustrates and describes a number of special applications of electric motors to steel works machinery. 1000 w. Engr, Lond—April 28, 1905. No. 69483 A.

Motor Drives in the Plant of the John Simmons Company. Illustrates and describes a number of interesting combinations in a New York shop. The aim was to make the machines capable of using high speed steel tools. 2000 w. Ir Age—May 25, 1905. No. 69855.

The Application of Electric Driving to Workshops (Antrieb durch Elektrische Motoren im Fabrikbetrieb). W. Zuppinger. Discussing especially the matter of belting from the electric motor to shafting for group driving, when large speed reductions are necessary. 3000 w. Schweiz Bauzeitung—April 15, 1905. No. 69731 B.

Foundry.

The Foundry of Scholten Bros. at Duisburg (Die Giesserei der Firma Gebr. Scholten in Duisburg). F. Wüst. Plans and description of a new foundry plant representing recent German practice. 3500 w. 1 plate. Stahl u Eisen—May 15, 1905. No. 69744 D.

The Sandycroft Foundry. Begins a detailed description, giving many illustrations. 2300 w. Engr, Lond—May 5, 1905. Serial. 1st part. No. 69597 A.

Interchangeable Parts.

Symbolling a Machine for Interchangeable Manufacture. F. W. McArdle. Describes a system with which the writer has had experience, which is particularly applicable to constructions that have many details. 2500 w. Amer Mach—Vol. 28, No. 19. No. 69505.

Keyway Cutting.

German Vertical Keyseating and Slotting Machine. Illustrated description of the machine and its operation. 800 w. Am Mach—Vol. 28, No. 21. No. 69860.

Lathes.

Electric Drive for Large Lathes. Oscar E. Perrigo. Illustrates and describes a method of applying the electric drive to existing lathes which has been found economical, convenient, and efficient. 700 w. Am Mach—Vol. 28, No. 18. No. 69380.

Feeds and Speeds for Lathe Work. T. A. Sperry. Gives results of observations at the works of the Cincinnati Milling Machine Company, showing the speeds and feeds at which iron and steel are being machined to-day. 1100 w. Am Mach—Vol. 28, No. 21. No. 69859.

Machine Tools.

Recent Machine Tools (Neuere Werkzeugmaschinen). Paul Möller. Illustrating some recent German designs for lathes and slotting machines. 2000 w. Zeitschr d Ver Deutscher Ing—April 22, 1905. No. 69706 D.

Molding.

Mounting a Shuttle-Box Pattern on a Molding Machine. John Weaver. Illustrates and describes a method of mounting patterns. 1600 w. Am Mach—Vol. 28, No. 21. No. 69858.

Molds.

New Method of Drying Large Molds. Henry Biegel. Illustrates and describes a method of drying with stoves. 700 w. Am Mach—Vol. 28, No. 19. No. 69503.

We supply copies of these articles. See page 638.

Pattern Making.

Developing the Pattern for a Copper Converter Hood Having a Round Top and an Irregular Base. John O. Wyler. Directions for this work, with diagrams. 2000 w. Boiler Maker—May, 1905. No. 69391.

Pattern Shops.

Pattern Shop System. Oscar E. Perrigo. An explanation of plans and systems of handling the work satisfactorily. 4200 w. Foundry—May, 1905. No. 69546.

Perforating.

Sheet-Metal Perforating. Edward F. Chandler. Illustrates and describes a complete punch and die equipment. 600 w. Am Mach—Vol. 28, No. 18. No. 69382.

Pipe Threads.

Gages for Briggs Standard Pipe Threads and for Standard Oil Well Casing. F. A. Stanley. An illustrated detailed description of the method followed in making a new set of Briggs reference gages. 3000 w. Am Mach—Vol. 28, No. 18. No. 69379.

Screws.

Note on Heads of Machine Screws. H. G. Reist. Remarks on the variation of size and shape and the inconvenience caused, giving formula and table showing the shapes and dimensions of size of screws ordinarily used. 450 w. Trans Am Soc of Mech Engrs, No. 064—June, 1905. No. 69551.

Stores.

The General Stores-Keeping Department of the Browning Engineering Co. Earl Harrison Browning. A fully illustrated article showing the stores keeping methods, forms and appliances of a modern machine works. 3500 w. Engineering Magazine—June, 1905. No. 69794 B.

Stoves.

Labor Saving in Stove Manufacture. John Magee. From a paper read before the Nat. Assn. of Stove Mfrs. Briefly considers the labor-saving machinery and tools used, and the labor-saving shop methods. 2000 w. Ir Trd Rev—May 18, 1905. No. 69648.

Tools.

A Chucking Machine Fixture. Charles R. Richardson. Illustrated description of a device found very useful. 1000 w. Am Mach—Vol. 28, No. 20. No. 69619.

Shop Tools and Devices. F. J. LeCard. Brief illustrated descriptions of devices for holding steady rest work on the live center, and other useful attachments. 1500 w. Am Mach—Vol. 28, No. 18. No. 69381.

Works.

The Works of the Birdsboro Steel Foundry and Machine Company. Illustrated description of the plant of what was formerly known as the Diamond Drill & Machine Co., which has greatly enlarged the scope of work and assumed the new name. 3500 w. Ir Age—May 11, 1905. No. 69456.

The Works of Messrs. Brown-Boveri & Co., of Baden, Switzerland. Emile Guarini. Illustrated detailed description of large electric construction works and their equipment. 1800 w. Am Mach—Vol. 28, No. 20. No. 69616.

MATERIALS OF CONSTRUCTION.

Alloys.

The Constitution of Iron-Carbon Alloys. E. Heyn. Translated from *Zeitsch. f. Elektro-Chemie.* The writer's views regarding the phenomena occurring on the quenching and on the solidification of iron-carbon alloys. 2000 w. Ills. Ir & Steel Mag—May, 1904. Serial. 1st part. No. 69686 D.

Vanadium and Titanium. Hans Goldschmidt. The first part of an article on the effect of vanadium and titanium on steel. The present number deals with vanadium. 2000 w. Elec-Chem and Met Ind—May, 1905. Serial. 1st part. No. 69446 C.

Bearing Metals.

The Microstructure and Frictional Characteristics in Bearing Metals. Melvin Price. A record of investigations carried out in the laboratories of Columbia University. Considers the law of variation of the amount of friction with the velocity of sliding, and the theories of Charpy and Prof. Goodman. Ills. 10000 w. Trans Am Soc of Mech Engrs, No. 072—June, 1905. No. 69559 D.

Bronze.

Manganese Bronze. Percy Longmuir. An examination of some of the properties of this alloy. 1600 w. Foundry—May, 1905. No. 69545.

The Monumental Treatment of Bronze. J. Starkie Gardner. A review of the history of bronze as applied to monumental statuary and architectural decoration. Discussion. Ills. 10800 w. Jour Soc of Arts—May 12, 1905. No. 69698 A.

Cast-Iron.

Cast-Iron: Crushing Loads and Microstructure. W. J. Keep. A report of tests given with the object of making more complete the society's records of tests on cast iron. Ills. 2000 w. Trans Am Soc of Mech Engrs, No. 065—June, 1905. No. 69552 C.

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Metallography Applied to Foundry Work. Albert Sauveur. The first of a series of articles considering metallography in its application to the testing of castings. 2000 w. Foundry—May, 1905. Serial. 1st part. No. 69543.

Corrosion.

The Protection of Copper and its Alloys against Corrosion from Sea Water (Schutz des Kupfers und seiner Legierungen gegen die Zerstörung durch Seewasser). F. Uthemann. Data and results of experiments upon a number of alloys suitable for marine condenser tubes. 2000 w. Zeitschr d Ver Deutscher Ing—May 6, 1905. No. 69712 D.

The Corrosion of Copper in Sea Water. Translation of an article by Herr Uthemann, on a number of interesting experiments carried out with a view to discovering an effective means of protecting copper and its alloys against corrosion through the action of sea water. 2800 w. Engr, Lond—May 5, 1905. No. 69598 A.

"Fatigue."

Note on the Failure of an Iron Plate through "Fatigue." Sidney A. Houghton. Read before the Iron & Steel Inst. Describes a case and investigates the causes. 1700 w. Ir & Coal Trds Rev—May 12, 1905. No. 69890 A.

Hardening.

A Salt-Bath Furnace for Steel Hardening. Illustrates and describes an apparatus in which a fusible salt liquid is utilized for heating purposes; known as the Brayshaw furnace. 1300 w. Sci Am Sup—May 20, 1905. No. 69627.

Low Temperatures.

Experiments Relating to the Effect on Mechanical and Other Properties of Iron and Its Alloys Produced by Liquid Air Temperatures. R. A. Hadfield. Read before the Iron & Steel Inst. An account of early and recent research work in this field. 11000 w. Ir & Coal Trds Rev—May 12, 1905. No. 69884 A.

Steel.

Steel: Its Manufacture and Classification, with Special Reference to Hardening and Tempering. R. B. Hodgson. The present article considers briefly the methods of manufacture, comparison, between Siemens and Bessemer steels, and crucible cast steel. 2300 w. Prac Engr—May 5, 1905. Serial. 1st part. No. 69580 A.

Tool Steel.

The Development and Use of High-Speed Tool Steel. A discussion of J. M. Gledhill's paper. 5500 w. Am Inst of Min Engrs—May, 1905. No. 69854.

The Steel Hardening Metals. Joseph Hyde Pratt. From a paper on "Mineral Resources of the United States," issued by the U. S. Geol. Survey. Gives a list of the metals included under this head, discussing the properties resulting from their additions. 3500 w. Mach, N Y—May, 1905. No. 69304 C.

MEASUREMENT.

Ductility.

A Study of the Limit of Ductility (Zur Kenntnis der Streckgrenze). C. Bach. Experiments to determine the relation of the flow of metals under stress to the ultimate breaking strength. 1800 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 15, 1905. No. 69702 D.

Fragility.

Test for Fragility. Thorsten Y. Olsen. Abstract of a paper read before the Phila. Found. Assn. An illustrated article explaining the Fremont method of determining the fragility of iron and steel. Also discussed. 4500 w. Foundry—May, 1905. No. 69547.

Instruments.

Small Instruments of Measurement. Joseph Horner. Illustrates and describes various small instruments of precision, giving some account of the care needed in their manufacture and their uses. 3500 w. Cassier's Mag—May, 1905. No. 69285 B.

Laboratory.

The Material Testing Laboratory of the Pless Mines at Waldenburg in Silesia (Die Untersuchung von Verbrauchsmaterialien im Laboratorium der Fürstlich Plesschen Bergwerke zu Waldenburg in Schlesien). Fr. Schreiber. With results of tests of lubricants, belting, packing, and general supplies. Two articles. 7000 w. Glückauf—April 29, May 6, 1905. No. 69749 each D.

Measuring Machines.

Continuous Measuring and Mixing of Crushed or Powdered Materials in Accurate Proportions. E. N. Trump. Briefly outlines various methods in use, and gives an illustrated description of a measuring table, and explains how a combination will regulate the proportioning and mixing. 3500 w. Trans Am Soc of Mech Engrs, No. 071—June, 1905. No. 69558 C.

Oil Tester.

The Lahmeyer Oil Tester. H. E. Hodgson. Illustrated detailed description of an apparatus designed to be driven by an electric motor, by mechanical means, or by hand, explaining its operation. 3300 w. Elec Engr, Lond—April 28, 1905. No. 69468 A.

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Pyrometry.

Modern Thermometric Apparatus for High Temperatures. L. Ramakers. An illustrated account of a type of apparatus recently introduced by the Siemens & Halske Company, of Berlin. 1100 w. Sci Am—May 27, 1905. No. 69869.

Test Bars.

Test Bars. B. J. Dunning. Gives the writer's experience in trying to determine what the test bar tells. 1400 w. Foundry —May, 1905. No. 69544.

Units.

Making the Best of Present Units. Sanford A. Moss. Suggestions for a system of measurements that will give the calculations in decimals. Also editorial. 1800 w. Am Mach—Vol. 28, No. 20. No. 69620.

POWER AND TRANSMISSION.

Belts.

Belt Creep. William W. Bird. Gives a report of investigations of the minimum amount of slip of a belt in transmitting power, concluding that for the common leather belt running under ordinary conditions the creep should not exceed one per cent. 1000 w. Ills. Trans Am Soc of Mech Engrs, No. 073—June, 1905. No. 69560.

Greater Power for Belt-Driven Plants. Frank Jordan. Claims that "the slacker the belt, the greater the power transmittable." 1800 w. Prac Engr—May 5, 1905. No. 69581 A.

Coal Handling.

The Shadyside Coal Storage Plant of the New York Edison Co. Illustrated description of the plant and its handling apparatus. It provides for 100,000 tons of anthracite and 50,000 tons of bituminous coal. 1500 w. Eng Rec—May 13, 1905. No. 69569.

Clutch.

An Improved Clutch (Sur un Nouvel Embrayage). MM. de Guiche and Gillardoni. Describing a clutch consisting of a friction shoe acting upon the interior of a drum by means of a toggle link. 1000 w. Comptes Rendus—April 25, 1905. No. 69724 D.

Compressed Air.

Air Compression at Altitude. Frederick M. Hitchcock. Showing the increase of power required at altitude to compress a volume of air equivalent in effect to a given volume at sea level. 1200 w. Mines & Min—May, 1905. No. 69409 C.

Classification of Air Compressors. Robert Peele. Gives classification by characteristics purely as engines, by mode of dealing with heat produced, by types of valves and valve motions. 2500 w. Mines & Min—May, 1905. No. 69403 C.

Compound Air Compression. Frederick M. Hitchcock. Considers the temperatures attained, effects of cooling, power consumed, and saving by compound compared with simple compression. 2500 w. Mines & Min—May, 1905. No. 69411 C.

Compressed Air Grain Shoveling. J. G. Westbrook. Illustrates and describes the equipment for a large grain-house. 800 w. Compressed Air—May, 1905. No. 69632.

Compressed Air on the Pacific Coast. Edward A. Rix. Illustrates and describes compressors driven by direct-connected water-wheels, and the various methods of using and reheating air. 4000 w. Mines & Min—May, 1905. No. 69399 C.

Compression of Air and Volumetric Efficiency. E. A. Rix. Gives theoretical data and their application to practical problems of compressed air machinery. 4800 w. Mines & Min—May, 1905. No. 69405 C.

Efficiency Test of a Nordberg Air Compressor at the Burra Burra Mine of the Tennessee Copper Company. J. Parker Channing. Describes the conditions and the methods of testing, reporting results. 1500 w. Mines & Min—May, 1905. No. 69401 C.

Electrical Compression of Air for Mining Purposes. Lucius I. Wightman. An illustrated article describing the electrical air compressor, and considering driving by belts, ropes, gears, silent chains, and direct connections, sizes of units, &c. 7400 w. Mines & Min—May, 1905. No. 69413 C.

Long Stroke Pump Valves (Vollhubige Pumpenventile). F. Strnad. Illustrating improved forms of balanced, cushioned ring-valves, especially adapted for gas and vacuum pumps and for air compressors. 5000 w. Glückauf—April 22, 1905. No. 69746 D.

Long-Stroke Valves for Compressors (Vollhubventile für Kompressoren). Ferd. Strnad. Describing an improved form of cushioned valve for high speed air compressors. 2500 w. Zeitschr d Ver Deutscher Ing—April 29, 1905. No. 69708 D.

Reheaters and Reheating. States the advantages gained by reheating, giving illustrated descriptions of different types of reheaters. 1800 w. Mines & Min—May, 1905. No. 69408 C.

The High-Speed Compressor. Joseph D. Cone. Explains its advantages for certain work, giving examples of compressors direct driven by electric motors,

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gas engines, and steam. Ills. 2400 w. Mines & Min—May, 1905. No. 69406 C.

The Taylor Hydraulic Air Compressor. William O. Webber. On the advantages of the system and its high efficiency, discussing some distinct features and peculiarities. 1300 w. Mines & Min—May, 1905. No. 69412 C.

Vertical Air Compressors. Brief illustrated descriptions of enclosed and open two-stage compound compressors as examples of recent English practice, giving a test record. 800 w. Mines & Min—May, 1905. No. 69402 C.

Cranes.

Electric Locomotive Cranes. Illustrates four different types of electrically worked locomotive cranes, giving brief descriptions. 600 w. Engr, Lond—April 21, 1905. No. 69343 A.

Fundamental Principles of Electric Crane Design (Grundbedingungen für den Bau von Elektrisch Betriebenen Laufkranen). S. Herzog. A very complete discussion of the detailed design of the modern three-motor electric traveling crane. 3500 w. Zeitschr f Elektrotechnik—May 14, 1905. No. 69781 D.

Gears.

A General Theory of Spur Gearing. Robert A. Bruce. Gives a general method for determining the correct forms for the profiles of wheel teeth which does not demand a knowledge of mathematics. 1600 w. Prac Engr—May 12, 1905. Serial. 1st part. No. 69816 A.

An Interesting Pair of Spiral Intermittent Gears. Illustrates and describes the operation of a pair of intermittent gears having peculiar characteristics. 700 w. Am Mach—Vol. 28, No. 21. No. 69857.

Some Points About Tumbler Gears. A. L. de Leeuw. Discusses the line of action, and the calculating the strain on the different parts. Diagrams. 2300 w. Am Mach—Vol. 28, No. 19. No. 69502.

Handling Grain.

Grain Storage and Manipulation at the Quayside. Brysson Cunningham. Illustrates and describes modern methods, with special reference to the practice at British ports. 3000 w. Cassier's Mag—May, 1905. No. 69286 B.

Hoisting.

Modern Steam Hoisting Machinery. A. M. Levin. Illustrates and describes some features in the design of hoisting engines and auxiliaries. 3800 w. Mach, N Y—May, 1905. No. 69302 C.

Pneumatic Tubes.

The Pneumatic Tube System of St. Louis. Edward D. Sabine. A description of the system of the Post Office Department and its successful working. 2500 w. Compressed Air—May, 1905. No. 69631.

Shafting.

Precise Lining of Large Shafting. W. I. Fleck. Describes a particular setting which illustrates the more important features of the method, giving a drawing of the relative position of the horizontal and vertical boxing, shafting, gearing, &c., necessary for the transmission of 1,600 H. P. from four water wheels. 700 w. Min & Sci Pr—May 20, 1905. No. 69915.

Variable Speeds.

Variable Speed Mechanisms. The present article considers their development and general principles. Ills. 2200 w. Mach, N Y—May, 1905. Serial. 1st part. No. 69303 C.

STEAM ENGINEERING.

Binary Vapor.

Waste Heat Engines (Abwärmekraftmaschine). H. Schröter. Data and results of tests upon two binary-vapor engines of the Josse sulphurous acid type, showing the gain by utilizing the heat in the exhaust steam. 1800 w. Zeitschr d Ver Deutscher Ing—May 6, 1905. No. 69713 D.

Boilers.

Boiler Room Economics. F. A. Lankashier. Abstract of a paper presented before the Iowa Elec. Assn. Especially considers boilers and grates, discussing types. 2500 w. Engr, U S A—May 1, 1905. No. 69362 C.

Cleaning Boilers. James T. Fennell. Gives suggestions for properly blowing off a boiler, and how to get a boiler ready for cleaning out. 1800 w. Power—May, 1905. No. 69416 C.

Marine Type Water Tube Boilers. C. C. Thomas. A review of the investigations and report of the Boiler Committee appointed by the British Admiralty to examine the water-tube boiler question in all its details and make recommendations regarding the boilers to be used on British ships of war. Ills. 2500 w. Sib Jour of Engng—May, 1908. No. 69660 C.

The Renard Boiler (La Chaudière du Colonel Renard). Describing a light weight flash steam boiler designed by the late Col. Renard. 800 w. Génie Civil—April 22, 1905. No. 69718 D.

Boiler Explosion.

The St. Lazare Boiler Explosion. An illustrated article reviewing the report of M. Charles Frémont in regard to the cause of the explosion of this locomotive boiler, on July 4, 1904. Also comments on the earlier report of M. Sylvain Périssé. 3000 w. Engr, Lond—April 21, 1905. Serial. 1st part. No. 69341 A.

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Boiler Furnaces.

Repairing Partly Collapsed Cylindrical Furnaces. John P. Cosgro. Describes method of remedying an injury which may occur from overloading the boilers. Ills. 2000 w. Am Inst of Min Engrs—May, 1905. No. 69850.

The Effect of Oil on Boiler Furnaces. D. B. Morison. Read before the N. E. Coast Inst. of Engrs. & Shipbuilding. Discusses means of determining the ultimate strength of a boiler furnace and the effect of oil upon it, giving a report of investigations. Ills. 3700 w. Engng—May 5, 1905. Serial. 1st part. No. 69595 A.

Chemistry.

Engine Room Chemistry.—Introductory. Augustus H. Gill. The first of a series of articles aiming to make engineers somewhat familiar with the substances with which they deal, as fuel, water and oil, and some points in connection with their use. 3000 w. Power—May, 1905. Serial. 1st part. No. 69417 C.

Condensing.

Cooling Water for Condensers. Ernest R. Briggs. Discusses methods in use and explains a method for finding correctly the quantity of water required for condensing purposes. Ills. 1600 w. Am Mach—Vol. 28, No. 20. No. 69618.

Diagrams.

The Theory of Steam Engine Diagrams (Beitrag zur Theorie der Dampfmaschinendiagramme). Viktor Blaess. A discussion of the influence of the dimensions of steam passages upon indicator diagrams, based upon the experiments of Gutermuth upon the flow of steam. 2000 w. Zeitschr d Ver Deutscher Ing—April 29, 1905. No. 69709 D.

Efficiency.

Notes on Efficiency of Steam Generating Apparatus. A. Bement. A paper suggested by the discussion of a previous paper on "More Exact Methods for Determining the Efficiency of Steam Generating Apparatus." Considers the efficiency of the boiler and of the furnace, and gives experimental results. Ills. 4000 w. Trans Am Soc of Mech Engrs, No. 074—June, 1905. No. 69561 C.

Some Notes on the Efficiency of Steam Plant. Walter A. Vignoles. Discusses points in connection with the running of central stations, based on tests made, and giving conclusions. 4000 w. Elect'n, Lond—April 28, 1905. No. 69472 A.

Engines.

6,000-I.H.-P. Engines for the Manchester Corporation. Illustrated description of a pair of vertical slow-speed engines, which are believed to be the largest at present existing in Europe. 800 w. Engng—April 28, 1905. No. 69478 A.

The Lentz Engine. Illustrated description of a large compound engine for coupling direct to a dynamo, working with superheated steam of high temperature. 800 w. Engr, Lond—April 21, 1905. No. 69347 A.

Fuel Economy.

The Province of the Fuel Expert. G. A. Hutchinson. Considers some of the problems likely to present themselves in connection with a steam plant. 3800 w. Eng & Min Jour—May 25, 1905. No. 69903.

Fuels.

Molasses as Fuel. R. Terry, S. Arnold, and H. Fisher. Gives report of investigation carried out in the Mechanical Engineering Laboratories of Columbia University to determine its efficiency when atomized in conjunction with fuel oil. Ills. 3500 w. Sch of Mines Qr—April, 1905. No. 69635 D.

Governors.

Steam Engine Governors. Considers points in connection with their design. 2700 w. Mech Engr—April 22, 1905. Serial. 1st part. No. 69327 A.

Heating Surface.

The Value of Heating Surface for Steaming and Superheating in Locomotive Boilers (Der Wert der Heizfläche für die Verdampfung und Ueberhitzung im Lokomotivkessel). H. Strahl. A discussion of experiments upon the transmission of heat in various parts of a locomotive boiler. 4000 w. Zeitschr d Ver Deutscher Ing—May 6, 1905. No. 69711 D.

Indicators.

Indicator Inertia. Deductions from engine trials made by G. S. Rose and G. Savory at Sibley College, U. S. A. 1200 w. Engng—May 12, 1905. No. 69828 A.

Paper Mills.

Steam Engineering in Paper Mills. E. S. Farwell. Considers the special problems of paper mills which are not common to all steam plants, showing where attention is needed. 2500 w. Cassier's Mag—May, 1905. No. 69284 B.

Piping.

The Steam Piping of a Small Lighting Station. R. T. Strohm. Describes the two systems in general use, explaining the advantages of each. 1600 w. Am Elect'n—May, 1905. No. 69358.

Power Plants.

See Electrical Engineering, Generating Stations.

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Smoke.

Smoke and Its Abatement. Charles H. Benjamin. A discussion of the problem of abating the smoke from bituminous coal. 6500 w. Trans Am Soc of Mech Engrs, No. 060—June, 1905. No. 69548 C.

Steam Turbines.

Can a Steam Turbine be Started in an Emergency Quicker Than a Reciprocating Engine of the Same Power? A. S. Mann. Showing that the turbine can be brought up to speed much quicker than the engine. 1400 w. Trans Am Soc of Mech Engrs, No. 068—June, 1905. No. 69555.

Flow of Steam Through Turbine Nozzles. Newton Wright. Gives formulas for calculating the energy of 1 lb. of steam. 3000 w. Prac Engr—May 12, 1905. No. 69818 A.

Steam Turbines. A discussion, opened by Prof. H. W. Spangler. Ills. 10500 w. Jour Fr Inst—May, 1905. No. 69637 D.

The De Laval Turbine. W. S. Ford. A discussion of this steam turbine, its operation, efficiency, &c. Ills. 2000 w. Sib Jour of Engng—May, 1905. No. 69661 C.

See also Marine and Naval Engineering.

Superheaters.

Performance of a Superheater. A. Bement. Gives diagrams plotted from a large number of experiments, discussing the results shown. 700 w. Trans Am Soc of Mech Engrs, No. 076—June, 1905. No. 69563.

Specific Heat of Superheated Steam. R. C. H. Heck. Describes the first method used for the determination by measurement of total heat, and experimental work in this field. 2000 w. Power —May, 1905. No. 69418 C.

Superheated Steam. J. L. Moore. Explains the aim in the use of superheated steam, gives results of tests, and conclusions. General discussion. 3500 w. Pro Engrs' Soc of W Penn—May, 1905. No. 69641 D.

Vacuum.

The Effects of Vacuum on Steam-Engine Economy. R. M. Neilson. Mr. Neilson's second paper describes the leading types of condensing apparatus, and their operation. 3000 w. Engineering Magazine—June, 1905. No. 69796 B.

The Measurement of Vacuum. C. Turnbull. Read before the Newcastle Loc. Sec. of the Inst. of Elec. Engrs. Remarks on the methods and the importance of vacuum measurements. 700 w. Engr, Lond—April 21, 1905. No. 69349 A.

Valve Gear.

Steam Actuated Valve Gear. W. H. Collier. Illustrated description of a 14 x 30 engine running 100 revolutions per minute, developing from 80 to 120 h.-p., with a statement of the advantages claimed. 1800 w. Trans Am Soc of Mech Engrs, No. 061—June, 1905. No. 69549.

Vibration.

Counterweights for Large Engines. D. S. Jacobus. Discusses the effects from the application of counterweights to an exceptionally large engine to lessen the vibration, with satisfactory results. An investigation of the action of the counterweights, and their effect on other electrical problems. Ills. 4500 w. Trans Am Soc of Mech Engrs, No. 069—June, 1905. No. 69556 C.

Water Purification.

The Development of Water Purification in the United States. C. Herschel Koyl. A review of the subject, especially the work of the Ry. Mas. Mechs.' Assn. commencing in 1870, and a description of water-softening machines. 3500 w. R R Gaz—Vol. XXXVIII., No. 19. No. 69513.

MISCELLANY.

Aeronautics.

The Longitudinal Stability of Dirigible Balloons (Sur la Stabilité Longitudinale des Ballons Dirigeables). L. Torres. A review of the method suggested by Col. Renard, showing the disturbing effect of weight at the rear of the balloon. 1200 w. Comptes Rendus—April 10, 1905. No. 69722 D.

The Montgomery Aeroplane. Illustrated description, with an account of the successful trial on April 29th. 1600 w. Sci Am—May 20, 1905. No. 69622.

Carpet Cleaning.

Automobile Compressed Air Plant for Carpet Cleaning. Illustrated description of a novel form of motor vehicle recently built for service in South Wales. 500 w. Engr, Lond—April 21, 1905. No. 69346.

Force.

The Notion of Force (Der Kraftbegriff). H. Wehage. An examination of the correct definition and conception of the mechanical term force. 1800 w. Zeitschr d Ver Deutscher Ing—April 15, 1905. No. 69703 D.

Gas Bottles.

Bottles for Compressed Air and Liquified Gases (Flaschen zur Aufnahme Verflüssigter und Verdichteter Gase). A. Martens. Data and results of tests of containers for gases under pressures up to 400 atmospheres, with comments on various materials for this service. 4000 w. Zeitschr d Ver Deutscher Ing—April 15, 1905. No. 69701 D.

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MINING AND METALLURGY

COAL AND COKE.

Borneo.

Coal Mining in Borneo. Extracts from a paper by James Roden, read before the Min. Inst. of Scotland. Gives details of some of the mines and their methods of working. 1500 w. Col Guard—May 5, 1905. No. 69592 A.

The Government Mines, Sadong-Sarawak, Borneo. Extracts from a paper by B. Hart Huxham, read before the S.-Wales Inst. of Engrs. Information in regard to this coalfield and its development. 2000 w. Col Guard—April 28, 1905. Serial. 1st part. No. 69474 A.

Coal Cutters.

Compressed Air Coal Cutters. L. T. Wightman. An illustrated description of the new Ingersoll type of puncher, also of the new "Radial" coal cutter. 3000 w. Mines & Min—May, 1905. No. 69407 C.

Coal Dust.

Separation of Dust from Coal. Explanatory drawings of two systems of recovering the very fine dust in a condition fit for firing, or briquette making. 1000 w. Ir & Coal Trds Rev—May 5, 1905. No. 69603 A.

Coal Fields.

The Known Coal Fields of the United States. E. W. Parker. Interesting information concerning the coal deposits, with map showing areas of coal bearing formations. 3000 w. Min Wld—May 6, 1905. No. 69422.

Coal Lands.

Recent Practice in Examination of Coal Lands. George H. Ashley. States the main things to be determined, and outlines the methods now used. 1700 w. Min Wld—May 6, 1905. No. 69424.

Colorado.

The Occidental and Other Coal Mines of Huerfano County, Colorado. Arthur Lakes. An illustrated description of the geology and development of the region. 1800 w. Mines & Min—May, 1905. No. 69400 C.

The South Park Coal Field. A. Lakes. Description of this region, giving illustration showing coal line. 700 w. Min Rept —April 27, 1905. No. 69291.

Mexico.

Mexican Coal Deposits. Kirby Thomas. Information concerning the deposits, their value, and degree of development. 1800 w. Min Wld—May 6, 1905. No. 69423.

Sampling.

Commercial Value of Coal Mine Sampling. Marius R. Campbell. Recommends certain rules for mine sampling, based on experience in receiving coal for the government coal-testing plant at St. Louis. 1600 w. Min Wld—May 20, 1905. No. 69692.

Stope Fillings.

The Compression of Stope Fillings. Bergassessor Jacob Oberhausen, in *Glückauf*. Gives data as to the compressibility of the filling derived from experiments made at shaft No. 2 of the Kaiser mine in the Ruhr coal district. 1200 w. Sch of Mines Qr—April, 1905. No. 69633 D.

COPPER.

Anaconda.

The Metallurgy of Copper at Anaconda, Montana. A. P. Mallon. Outlines the rather complicated treatment of the ore, tracing its changes from the concentrator to the shipping from the refinery. 1500 w. Min & Sci Pr—May 20, 1905. No. 69914.

Arizona.

Geology of the Cochise Mining District, Arizona. Robert P. Franke. Illustrated description of this copper district and its ores. 700 w. Min Rept—May 18, 1905. No. 69696.

Ore Deposit.

Notes on a Low Grade Copper Ore Deposit in the Himalayas. F. J. Stephens. Read before the Inst. of Min. & Met. Gives a description of the general geology of the region, and of the ore deposit. 2500 w. Min Jour—May 20, 1905. No. 69923 A.

Ores.

Platinum and Palladium in Certain Copper Ores. Thomas T. Read. Deals with the presence of platinum in the rich copper sulphide ore of the Rambler mine, in Wyoming. 2500 w. Eng & Min Jour —May 25, 1905. No. 69902.

Slag-Treatment.

Improved Method of Slag-Treatment at Argo. Harold V. Pearce. Describes the improved copper smelting practice at this plant in Colorado. Ills. 2800 w.

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Am Inst of Min Engrs—May, 1905. No. 69849.

GOLD AND SILVER.

Amalgamation.

Effect of Salt and Bluestone on Mercury in Pan Amalgamation. A. E. Drucker. Explains the reactions which show the need of bluestone and salt in the treatment of silver ores when silver sulphide is present. 1000 w. Min & Sci Pr —May 20, 1905. No. 69916.

Assaying.

Correcting an Error in the Fire Assay. Charles Finley Easton. Discusses the unavoidable errors in fire assay, and describes an improvement which is based on the recovery of losses of gold by cupellation, giving results of some experiments. 2800 w. Min Rept—May 18, 1905. No. 69695.

Bornite Ores.

Bornite Ores of British Columbia and the Yukon Territory. William M. Brewer. Read before the Can. Min. Inst. Gives the history of the discovery of this ore, and a study of the geology and mineralogy of the deposits. 3300 w. Can Min Rev—April, 1905. No. 69289 B.

Cobalt-Silver.

On the Discoveries of Cobalt Silver Ores in Ontario. A brief account of the discovery, describing the deposits, and giving information of the present operating properties. Ills. 1500 w. Can Min Rev—April, 1905. No. 69287 B.

Cripple Creek.

The Cripple Creek District. John Wellington Finch. Discusses present conditions, reviewing the past year, the discoveries and development, and the general adoption of the leasing system. 4500 w. Min Mag—May, 1905. No. 69536 C.

Dredges.

A Large Gold Dredger. Illustrated description of the construction and operation of a modern dredger said to be the largest placer mining dredger in the world. Also reviews the early history of dredging in California. 3800 w. Min & Sci Pr—May 6, 1905. No. 69526.

Egypt.

An Egyptian Gold Mine. H. R. Sleeman. Read before the Inst. of Min. & Met. Describes the property known as the "Haimur," situated in the Nubian Desert, which shows unusual characteristics, also the ancient methods of mining and treating the ore. 4000 w. Min Jour —May 20, 1905. No. 69924 A.

Gold.

Gold and Its Associations. George P. Merrill. Gives a list of the associations shown in a collection at the National Museum. 2000 w. Eng & Min Jour—May 25, 1905. No. 69905.

India.

Notes on the New Dharwar Gold Field of India. R. O. Ahlers. A description of this recently opened field. 4500 w. Inst. of Min & Met—April 13, 1905. No. 69329 D.

Mexico.

La Mina Santa Francisca, Mexico. Edward H. Cook. An illustrated description of this silver mine, with a review of its history. 2000 w. Min Mag—May, 1905. No. 69537 C.

The Hostotipaquillo District, Jalisco. William N. Cummings. Map and description of this silver-gold district in Mexico. 2000 w. Eng & Min Jour—May 18, 1905. No. 69801.

The Moctezuma District, Mexico. M. Clere. An illustrated brief account of the mining conditions in the northern part of this district. Copper, silver and gold, with other ores are mined. 2500 w. Eng & Min Jour—May 25, 1905. No. 69907.

Milling.

Milling Gold Ores. Algernon Del Mar. A warning in regard to mill construction and fast crushing, unless the gold can be saved as fast as the ore is crushed. 900 w. Min & Sci Pr—May 13, 1905. No. 69674.

Milling Practice at the Camp Bird. Stephen L. Goodale. Describes the method of treating gold ores at this Colorado mine. Ills. 1300 w. Eng & Min Jour—May 4, 1904. No. 69388.

Mill Practice on the Rand. G. A. Denny. Illustrated description of a representative ore reduction and slimes treatment plant. 1200 w. Min Mag—May, 1905. No. 69534 C.

New Zealand.

The Hauraki Goldfields. Percy Morgan. Letter to the editor, discussing a recent article by Waldemar Lindgren on this subject. 2300 w. Eng & Min Jour —May 4, 1905. No. 69390.

Placer Mining.

Placer Mining in Antiognia, Colombia. F. F. Sharpless. Description of this field, with remarks on the work that has been done, the difficulties, &c. 2500 w. Eng & Min Jour—May 25, 1905. No. 69906.

Precipitation.

Precipitation of Gold and Silver from Cyanide Solutions. W. J. Sharwood. Considers the recovery of precipitation of gold and silver from their cyanide solutions. 800 w. Min & Sci Pr—April 29, 1905. Serial. 1st part. No. 69396

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Quebec.

The Bed-Rock of the Gilbert River Gold Fields, Quebec. John A. Dresser. Describes the character of the rock, discussing the conclusions indicated. 1000 w. Can Min Rev—April, 1905. No. 69288 B.

Queensland.

Charters Towers District, Queensland, Australia. C. M. Naylor. Gives the history of this field, the methods of work, metallurgical treatment of the ore, and the present condition of the industry. 2500 w. Min & Sci Pr—April 29, 1905. No. 69395.

Refining.

Note on the Refining of Base Bullion. Walford Dowling. Describes a method employed by the writer for the refining of very base bullion. General discussion. 2200 w. Jour Chem, Met, & Min Soc of S Africa—March, 1905. No. 69815 E.

Reprecipitation.

Reprecipitation of Gold from Cyanide Solutions and Absorption of Gold by a Wooden Leaching Vat. A. N. Mackay. Read before the Inst. of Min. & Met. Describes two cases of reprecipitation, and the case of absorption. 900 w. Min Jour—May 20, 1905. No. 69922 A.

Smelting.

Customs Smelting in Australia. Explains the circumstances that prevent the business from becoming profitable. 1600 w. Eng & Min Jour—May 11, 1905. No. 69507.

Stamp Stems.

Retapering the Broken Ends of Stamp Stems. Paul J. Johnson. Sketch and explanation which will enable one to retaper the stems on the floor of the mill. 500 w. Min Rept—May 25, 1905. No. 69921.

Tube Mills.

First Results of Tube Mill Practice at the Treasury Gold Mine. H. Leupold. Gives the results of the first two runs. 1600 w. Jour S African Assn of Engrs —March, 1905. No. 69873 F.

Tube Milling of Gold Ores. George P. Scholl. An illustrated article giving a general idea of the construction of tube mills and their operation, and data regarding installations. 4000 w. Min Mag —May, 1905. No. 69535 C.

IRON AND STEEL.

Asphyxiation.

Accidents Due to the Asphyxiation of Blast Furnace Workmen. B. H. Thwaite. Read before the Iron & Steel Inst. A discussion of the dangers, giving suggestions with a view to securing comparative immunity from fatalities. 2800 w. Ir & Coal Trds Rev—May 12, 1905. No. 69891 A.

Bertrand Thiel.

Recent Developments of the Bertrand-Thiel Process in the Manufacture of Steel. John H. Darby. Read before the Iron & Steel Inst. A résumé of recent developments. Ills. 1800 w. Ir & Coal Trds Rev—May 12, 1905. No. 69886 A.

Blast Furnaces.

An Improvement in Cooling Jackets for Blast Furnaces. David Baker. Describes a jacket, designed by the writer, where the water collecting trough is outside of the furnace. Ills. 1400 w. Ir & Steel Mag—May, 1905. No. 69679 D.

Stock-Distribution and Its Relation to the Life of a Blast-Furnace Lining. Discussion of Mr. Baker's paper. 2700 w. Am Inst of Min Engrs—May, 1905. No. 69853.

Sulphur in Coke and Its Behavior in the Blast Furnace. Prof. F. Wuest, and P. Wolff. A report of investigations and conclusions. 8300 w. Ir & Coal Trds Rev—May 12, 1905. No. 69892 A.

The Blast-Furnace Gas-Power Plant at the Ilseder Iron and Steel Works. G. Hooghwinkel. Illustrates and describes the equipment and working of the plant. 1200 w. Elec Engr, Lond—May 12, 1905. No. 69823 A.

The Cleaning of Blast-Furnace Gas. Axel Sahlin. Read before the Iron & Steel Inst. Considers the process of cleaning as regards the degree of purity reached, and the cost of reaching it. 4000 w. Ir & Coal Trds Rev—May 12, 1905. No. 69888 A.

The Preheating Zone of the Blast Furnace (Die Vorwärmzone des Hochofens). Fr. Schraml. Discussing methods of utilizing the heat of the waste gases for warming the charge before it is delivered into the shaft of the furnace. 3000 w. Stahl u Eisen—May 15, 1905. No. 69742 D.

Blowing Engines.

Gas Blowing Engines. Tom Westgarth. Abstract of a paper before the West of Scotland Iron and Steel Inst. Gives illustrations of various types, with brief descriptions, and information in regard to the running and the care and cost. 2000 w. Engr, Lond—May 5, 1905. No. 69602 A.

Concentration.

The Concentration of Iron Ores (Ueber Anreicherung von Eisenerzen). Dr. A. Weiskopf. An examination of the various magnetic devices for concentrating iron ores, with especial reference to Swedish practice. Two articles. 4000 w. Stahl u Eisen—April 15, 1905. No. 69736 each D.

We supply copies of these articles. See page 638.

Continuous Process.

The Continuous Steel Process in Fixed Furnaces. S. Surzycki. Read before the Iron & Steel Inst. Describes this process which can be carried out in any fixed furnace of not less than 25 tons capacity. 2500 w. Ir & Coal Trds Rev—May 12, 1905. No. 69887 A.

Dry-Air Blast.

The Application of Dry-Air Blast to the Manufacture of Iron. Discussions of Mr. Gayley's paper. 8200 w. Am Inst of Min Engrs—May, 1905. No. 69847 C.

The Application of Dry-Air Blast. (Supplementary Paper.) James Gayley. Read before the Iron & Steel Inst. Gives in detail the record of operations of the Isabella furnaces from Nov., 1904, to March, 1905, inclusive. 8000 w. Ir & Coal Trds Rev—May 12, 1905. No. 69885 A.

The Gayley Dry-Air Blast Process (Das Gayleysche Verfahren der Trocknung des Gebläsewindes für den Hochofen). Alfred Lindner. A critical review of the Gayley process, claiming that the method is incapable of producing the results. 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 29, 1905. No. 69757 D.

The Gayley Dry Air Blast. James Gayley. Supplementary data to the paper on this subject presented to the Iron and Steel Inst. 2000 w. Ir Age—May 11, 1905. No. 69459.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Furnaces.

American Furnace Construction (Amerikanische Ofenkonstruktion). Bernhard Osann. Discussing especially the masonry work and refractory lining of blast and open-hearth furnaces in American practice. 3000 w. Stahl u Eisen—May 1, 1905. No. 69739 D.

Heating.

The Transfer of Heat at High Temperatures. Frank C. Wagner. Describes experiments made to determine the time required to raise plates of iron and steel to a welding temperature in an open hearth regenerative furnace. 1700 w. Trans Am Soc of Mech Engrs, No. 075—June, 1905. No. 69562 C.

Hematite.

The Clinton Hematite. Edwin C. Eckel. Gives results of a recent investigation of these ores, with analyses. Ills. 1800 w. Eng & Min Jour—May 11, 1905. No. 69508.

Ingots.

Compression of Steel by Wire-Drawing During Solidification in the Ingot Mould. Examines the cases of ingots left to shrink freely, ingots subject to compression by the Whitworth system, and by compression by wire-drawing by the Harmet system, fully describing and illustrating the last method. 8400 w. Jour U S Art—March, 1905. No. 69612 D.

Iron District.

The Iron Industry in the Minette District (Die Eisenindustrie des Minettebezirks). A tabulated view of the iron industry in the district included in Lorraine, Luxembourg, and eastern France, with map. 2000 w. 1 plate. Stahl u Eisen—May 1, 1905. No. 69740 D.

The Oolitic Iron-Ore Deposits of Lorraine. From an article by Mons. L. Bailly, in the *Annales des Mines*. Describes the deposits and the methods of working, cost, &c. 4500 w. Ir & Coal Trds Rev—April 21, 1905. No. 69350 A.

Iron Works.

The Cargo Fleet Works. Illustrations, with description of these reconstructed works which are intended to produce structural steel and to use up all the iron coming from their own blast furnaces. 3000 w. Engr, Lond—May 12, 1905. Serial. 1st part. No. 69833 A.

Lake Superior.

A Summary of Lake Superior Geology with Special Reference to Recent Studies of the Iron-Bearing Series. C. K. Leith. Description of the geology of the iron-bearing and copper-bearing series, their structure and distribution, &c. Ills. 19300 w. Am Inst of Min Engrs—Sept., 1904. No. 69842 D.

Open-Hearth.

The Influence of Carbon, Phosphorus, Manganese and Sulphur on the Tensile Strength of Open-Hearth Steel. A discussion of Mr. Campbell's paper. 2000 w. Am Inst of Min Engrs—May, 1905. No. 69848.

Water Cooled Parts for Open Hearth Furnaces. Illustrates and describes a device invented by George L. Davison and David R. Mathias. 1000 w. Ir Age—May 4, 1905. No. 69354.

Ore-Briquetting.

A Russian Ore-Briquetting Plant. Herr Zeidler in *Stahl und Eisen*. Plan and description of a plant constructed to deal with the oolitic and argillaceous brown iron ore obtained from the deposits in the Kertsch peninsula. 1800 w. Ir & Coal Trds Rev—May 5, 1905. No. 69604 A.

Recorder.

An Automatic Stock-Line Recorder for Iron Blast-Furnaces. J. E. Johnson, Jr. Describes a simple, durable, and inexpen-

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sive apparatus which gives by its continuous and automatic action, accurate information concerning the stock-line for every minute of the day. Ills. 3000 w. Am Inst of Min Engrs—Feb., 1905. No. 69843.

Roasting.

The Roasting of Iron Ores (Ueber das Rösten von Eisenerzen). Oscar Simmersbach. A discussion of the effect of roasting in driving off the volatile impurities in iron ore, and an examination of the ores adapted to this treatment. 3000 w. Glückauf—April 22, 1905. No. 69747 D.

Rolls.

Roll Turning: An Important Factor in the Iron and Steel Industry. W. S. Standiford. An illustrated description of a special department of work, describing the peculiar machines and methods. 4000 w. Engineering Magazine—June, 1905. No. 69792 B.

The Calibration of Rolls for I-Beams (Das Kalibrieren der Profilwalzen für I-Eisen). Carl Holzweiler. With table giving the dimensions of passes in rolls for I-beams, and plates showing the successful reductions. 2000 w. 2 plates. Stahl u Eisen—April 15, 1905. No. 69734 D.

Slags.

Experiments on the Fusibility of Blast Furnace Slags. O. Boudouard. Read before the Iron & Steel Inst. Reports of a systematic investigation of the fusibility of silicates of lime, and of alumino-calcic silicates. Ills. 7000 w. Ir & Coal Trds Rev—May 12, 1905. No. 69889 A.

Sulphur.

The Presence of Coke-Sulphur in the Blast Furnace (Das Verhalten des Koksschwefel im Hochofen). F. Wüst and P. Wolff. An examination of the proportion of sulphur carried into the blast furnace with the coke fuel. 3000 w. Stahl u Eisen—May 15. 1905. No. 69743 D.

Sweden.

The Grangesberg Iron Mines in Sweden. J. W. H. Hamilton. Illustrated description of the methods of working, electric power being largely used, and modern appliances. 2800 w. Eng & Min Jour—May 18, 1905. No. 69802.

Tires.

The Manufacture of Railway Tires and Axles (Die Fabrikation der Eisenbahnradreifen und Achsen). E. H. Steck. A detailed description of the methods of forging and rolling weldless tires and forging car axles, with especial reference to British practice. 4500 w. Stahl u Eisen—April 15, 1905. No. 69735 D.

MINING.

Blasting.

Explosion of a Triple Mine at the Passgrub Quarry near Greifenstein (Sprengung einer Dreikammermine im Passgrubsteinbruche nächst Greifenstein). Hugo Münch. Describing the method employed for the breaking down of a large quantity of stone by chamber mines. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—April 7, 1905. No. 69725 D.

Boring.

Methods of Boring and Sinking. Treats the subjects separately, giving an illustrated description of the best known methods. 9500 w. Ir & Coal Trds Rev—May 12, 1905. No. 69893 A.

Well Sinking and Boring Appliances. An illustrated description of appliances used in boring artesian wells and bore holes generally. 3000 w. Mech Engr—May 6, 1905. No. 69584 A.

Buildings.

The Administration Buildings of the Recklinghausen Mines (Das Kauen und Verwaltungsgebäude der Zeche Recklinghausen). H. Fuchs. An illustrated description, showing the toilet and bath arrangements for the miners, care of clothes, lamps, etc., as well as business offices. 2500 w. 2 plates. Glückauf—May 13, 1905. No. 69750 D.

Colorado.

Sketch of the Economic Resources of the Foothills of the Front Range of Colorado. A. Lakes. Describes these foothills, discussing the building stones and the economics of the sedimentary beds. 2000 w. Min Rept—May 25, 1905. No. 69920.

Conveying.

Methods of Conveying Spoil at the Wilczek Mines in Polnisch-Ostrau (Mitteilungen aus der Praxis des Schlämmverfahrens am Gräflich Wilczekschen Dreifaltigkeitsschachte in Polnish-Ostrau). J. Mauerhofer. The waste spoil of the mines is carried by the flow of water through pipes to the dump. Two articles. 1 plate. 4500 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 1, 8, 1905. No. 69752 each D.

Couplings.

Deterioration of Mine-Car Couplings. Walter H. Finley. Abstract of a paper read before the Engng. Assn. of the South. Describes a case of fatigue of metals by crystallization, and the method used to remedy the trouble. 800 w. Eng & Min Jour—May 4, 1905. No. 69387.

Drilling.

Diamond Drilling Under Difficulty. S. C. Thomson. Abstracted from a paper before the S. African Assn. of Engrs.

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Describes a drilling operation started at the bottom of a shaft of 2,525 ft., full of water, with no fixed guide for the drill rods in the last 95 ft. 1400 w. Eng & Min Jour—May 4, 1905. No. 69386.

Electric Driving.

Electric Driving of Stamp Batteries. L. Wilms. Gives points in favor of central station supply of power, showing that an increase in efficiency and saving in cost can be obtained. Discussion. 7000 w. Jour S African Assn of Engrs —Feb., 1905. No. 69351 F.

High-Tension Electrical Plant at Messrs. Bolckow, Vaughan and Co.'s Collieries. Illustrates and describes this plant showing the advantages and economies of the use of electricity in mines. 1200 w. Prac Engr—May 12, 1905. No. 69817 A.

Lambton Collieries Power Distribution Scheme. Gives a summary of the requirements and general conditions as shown in the specifications. 2500 w. Elec Rev, Lond—May 12, 1905. Serial. 1st part. No. 69826 A.

The Electrically Driven Semet-Solvay Coke Plant of the Wigan Coal and Iron Co., Ltd. Illustrated description of a plant the greater part of which is electrically driven. 2300 w. Elec Rev, Lond —May 12, 1905. No. 69825 A.

Explosives.

The Action of Explosives (Sprengwirkungen). C. E. Bichel. An examination of the action of various mining explosives, with table showing the volume of gas liberated, energy released, and other data. 3000 w. Glückauf—April 15, 1905. No. 69745 D.

Grinding.

Modern Crushing and Grinding Machinery. Philip Argall. Explains the writer's reasons for advocating crushing by "successive comminution." 1500 w. Eng & Min Jour—May 11, 1905. No. 69506.

Haulage.

New System of Haulage Adapted to Heavy Grades. Benedict Shubart. An illustrated description of the Morgan third-rail system. 1200 w. Min & Sci Pr —May 13, 1905. No. 69675.

Hot Springs.

Geology of the Hot Springs of Colorado and Speculations as to Their Origin and Heat. A. Lakes. Abstract of a paper read before the Colorado Sci. Soc. An interesting review of hot springs and their geological conditions, concluding that the heat is derived more from the great depth of fissures, or from latent heat, than from any direct volcanic source. 2000 w. Min Rept—May 11, 1905. No. 69565.

Lamps.

Precautions against Benzine Fires in Lamp Rooms (Sicherheitsvorkehrungen gegen Benzinbrand in den Lampenkammern). Dr. J. Fischer. Review of the official Austrian regulations concerning the filling and handling of miners' lamps. 1500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—April 15, 1905. No. 69756 D.

Lead-Assay.

The Commercial Wet Lead-Assay. Discussion of paper by H. A. Guess. 1200 w. Am Inst. of Min Engrs—May, 1905. No. 69852.

Leadville.

The Leadville District. A. W. Warwick. Historical notes on this district which produces silver, lead, gold, copper, zinc, iron ores and bismuth, considering some points of mining practice. 4000 w. Min Mag—May, 1905. No. 69538 C.

Mine Cars.

Mine Car Running Gear. R. V. Norris. Brief illustrated descriptions of various types of wheels and methods of lubricating. 1400 w. Eng & Min Jour—May 18, 1905. No. 69800.

Ore Handling.

Modern Ore Loading Plants and Wire Rope Tramways. Frank C. Perkins. Illustrates and describes modern systems of ore-handling apparatus, showing the great improvement and economy of methods now in use. 2500 w. Min Rept—April 27, 1905. No. 69290.

Ore Handling Plant at Conneaut, Ohio. Illustrated description of the arrangements for transferring of ore from the lake vessels to the cars or docks. The amount handled last year exceeded 4,000,000 long tons. 3500 w. Ir Age—May 25, 1905. No. 69856.

The Electric Ore Unloaders at Conneaut, Ohio. Illustrates and describes four electric ore unloaders, recently installed, for transferring the ore from ships to cars, or to storage pile. 1800 w. Elec Rev, N Y—May 6, 1905. No. 69397.

Ore Tests.

Place and Value of Small Scale Ore Tests. Ernest H. Simonds, in Trans. Cal. Min. Assn. Considers the advantages and disadvantages of each of the three general methods of making ore tests, especially discussing the method of making small scale tests in the laboratory, followed by the erection of one complete unit. 2200 w. Min & Sci Pr—April 22, 1905. Serial. 1st part. No. 69293.

Power Plants.

Economy in Operation of Coal Mine Power Plants. F. C. Weber. Presents the advantages claimed by the Corliss en-

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gine over other types of slow-speed engines for air compressors. 800 w. Mines & Min—May, 1905. No. 67404 C.

Pumping.

See Mechanical Engineering, Hydraulics.

Quarrying.

Air Power in the Quarry. Lucius I. Wightman. Describes a successful installation of a compressed-air plant at the Gray Cañon, showing that low economy is the result of careless management. 2200 w. Eng & Min Jour—May 4, 1905. Serial. 1st part. No. 69384.

Roasting.

Pyrometallurgical-Chemical Operations in Oxidizing Roasting (Pyrometallurgisch-Chemische Prozesse bei Oxydierendem Rösten). F. Janda. Reviewing the process of roasting as applied to iron, copper, lead, zinc, and other ores. Two articles. 4500 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 29, May 6, 1905. No. 69758 each D.

Sampling.

Mine-Sampling and Ore-Valuation. James Park. A discussion of methods of sampling, assaying, &c. 3000 w. N Z Mines Rec—March 16, 1905. No. 69522 B.

Shafts.

A Swinging Track. W. N. Cummings. Illustrates and describes a swinging track for shaft stations found useful in the opening of a prospect. 500 w. Eng & Min Jour—May 25, 1905. No. 69904.

Shaft Sinking by the Jetting Process. George C. McFarlane. Outlines a plan for sinking a round shaft lining, of steel jacketed concrete, provided at the lower end with a cutting shoe. Ills. 1700 w. Eng & Min Jour—May 11, 1905. No. 69509.

Signals.

An Electric Shaft Signal System (Elektrische Schacht-Signal-Anlage). F. Rüdorff. Illustrating the Siemens & Halske electric indicator and signal system, similar to the telegraph used on shipboard. 800 w. Glückauf—April 22, 1905. No. 69748 D.

Mine Bell Signals. Urges the importance of adopting a uniform code of mine signals. 2500 w. Min & Sci Pr—May 13, 1905. No. 69673.

Smelting.

The Michigan Smelter. R. T. White. Gives a ground plan of the works, describing the treatment of the ore and the methods. 2400 w. Eng & Min Jour—May 4, 1905. No. 69383.

Tubbings.

The Relative Strength of Corrugated and Ordinary Tubbings (Neues über die Festigkeitsverhältnisse Gewellter und Anderer Tubbings). Prof. Heise. An examination of the increase in resistance to external pressure in shaft linings by use of corrugated tubbings. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 8, 1905. No. 69754 D.

Valuation.

The Examination and Valuation of Mines. James Park. Information for young mining graduates. Ills. 5500 w. N Z Mines Rec—March 16, 1905. No. 69521 B.

Veins.

A Lost Orebody. Harold J. Read. Illustrates a peculiar break in a rich vein caused by a series of faults. 250 w. Eng & Min Jour—May 4, 1905. No. 69385.

Ventilation.

Centrifugal Fans for the Ventilation of Mines. John Hayes. With special reference to a fan recently designed to meet colonial requirements. 2700 w. Queens Gov Min Jour—March 15, 1905. No. 69356 B.

Winding.

Caps or Attachments for Winding Ropes. W. H. Becker. Read before S. Wales Inst. of Engrs. Gives a report of tests of rope caps showing that they do not equal 50 per cent. of the breaking strain of the ropes, and gives an illustrated description of a new cap that has held a rope to its full breaking strain. 2000 w. Col Guard—May 5, 1905. No. 69591 A.

Winding Ropes.

Deterioration of Winding Ropes. Extracts from a paper by J. A. Vaughan and W. M. Epton, read before the Transvaal Inst. of Mech. Engrs. Discusses the causes and gives recommendations to ensure safety. 2400 w. Col Guard (Sup.)—April 21, 1905. No. 69332 A.

MISCELLANY.

Briquetting.

Fuel and Mineral Briquetting. A discussion of the paper by Robert Schorr. 1000 w. Am Inst of Min Engrs—May, 1905. No. 69851.

Lead.

Lead: Its Ores, Compounds and Alloys. S. Barlow Bennett. The present article reviews briefly the lead mining industry in England, and discusses the important ores of this metal and their reduction. Ills. 2200 w. Plumb & Dec—May 1, 1905. Serial. 1st part. No. 69578 A.

New South Wales.

Tin Mining in New South Wales. P. J. Thibault. A summary review covering the period from 1900 to 1904 inclusive. 2000 w. Aust Min Stand—April 12, 1905. Serial. 1st part. No. 69523 B.

Oil.

Oil and Asphaltum on the Shores of Great Salt Lake, Utah. Don Maguire. Information concerning the prospect of finding oil, asphaltum and gas in Utah, as well as in Colorado and Wyoming. Ills. 1400 w. Min & Sci Pr—May 13, 1905. No. 69676.

Oil Fields.

The Production and Use of Electricity in a Russian Petroleum Field. Frank Koester. Brief account of the application of electricity to the drilling and pumping of the wells. Ill. 1000 w. Elec Rev, N Y—May 27, 1905. No. 69900.

Quicksilver.

The Terlingua Quicksilver District. Morris P. Kirk. Brief account of this district in Texas, discovered in 1892. 1000 w. Min Mag—May, 1905. No. 69539 C.

Rare Metals.

Rare Metals and Others. J. Ohly. Considers briefly the deposits of platinum, wolframite, titanium, &c. 800 w. Min Rept—May 18, 1905. No. 69697.

Sandstone.

The Sandstone of Salesiushöhe near Ossegg, Bohemia (Der Sandstein der Salesiushöhe bei Ossegg). Hans Hofer. With description of the strata, and map and section, and a discussion of the geological conditions. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—April 1, 1905. No. 69753 D.

Sapphires.

Sapphire Fields of Central Queensland. Lionel C. Ball. Notes on their present condition. Ills. 6500 w. Queens Gov Min Jour—March 15, 1905. No. 69355 B.

Tin.

The Carolina Tin Belt. Information concerning the development and economic importance of the deposits. 1200 w. Ir Age—May 11, 1905. No. 69458.

Tin in California. H. E. West. A brief description of the work at the San Jacinto tin mines in Southern California. 2000 w. Eng & Min Jour—May 4, 1905. No. 69389.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

New Zealand.

Electric Tablet System on New Zealand Railways. A detailed report, giving the regulations governing the working of the system. 16000 w. Cons Repts—April, 1905. No. 69838 D.

Pooling.

Pooling of Locomotives. A. M. Waitt. Explains the meaning of the term, discussing the advantages to the crews and to the railroad companies, and some of the disadvantages, but generally favorable to the practice. 2500 w. R R Gaz—Vol. XXXVIII., No. 18. No. 69429.

Switching.

Switching. F. A. Healy. A report submitted to the S. E. Accounting Conference at Nashville, Tenn., and unanimously recommended for adoption as the best system thus far introduced. 4800 w. Ry Age—May 19, 1905. No. 69666.

MOTIVE POWER AND EQUIPMENT.

Automatic Stokers.

Watching the Automatic Stoker at Work. Angus Sinclair. An account of a ride from Cincinnati to Indianapolis on an engine equipped with an automatic stoker. 2000 w. Loc Engng—May, 1905. No. 69312 C.

Brake Shoes.

The Development of the Modern Brake Shoe. F. W. Sargent. Reviews the progress since the use of wooden shoes, previous to 1850, and especially the development of the cast-iron shoe to its present degree of perfection. Ills. 4000 w. R R Gaz—Vol. XXXVIII., No. 18. No. 69435.

Car Heating.

Heating, Lighting and Ventilation of Cars. George L. Fowler. An outline of the development and present conditions of American practice. 5000 w. R R Gaz—Vol. XXXVIII., No. 20. No. 69658.

Cars.

High Capacity Cars. Rodney Hitt. Considers briefly the development of high capacity cars and the benefits derived from their use. 3300 w R R Gaz—Vol. XXXVIII., No. 20. No. 69656.

Coaling.

Coaling Locomotives. Charles H. Fry. Reviews early practice on American railroads, and describes many types of coaling stations tried on various roads, and the modern methods finally installed. Ills. 5200 w. R R Gaz—Vol. XXXVIII., No. 19. No. 69511.

Couplers.

Automatic Car Couplers. George Groobey. A study of these couplers, giv-

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ing ideas of many mechanical and operating officials, gathered during a nine months' tour of observation, and a statement of the requirements of the modern coupler. 3000 w. R R Gaz—Vol. XXXVIII., No. 19. No. 69510.

Couplings for Electrical Connections between Railway Cars (Ueber die Kupplung Elektrischer Leitungen Zwischen den Fahrzeugen der Vollbahnen). A. Mykish. With especial reference to the connections for electric signals and lighting on main-line trains. 2000 w. Glasers Annalen—May 15, 1905. No. 69783 D.

Dining Cars.

The Dining Car Department in America. Gives an idea of the first cost of a dining-car and its equipment, the operation and maintenance; discusses the problems to be solved to make the service satisfactory, and related matters. 1800 w. R R Gaz—Vol. XXXVIII., No. 20. No. 69653.

Electric Traction.

On the Question of Electric Traction. M. F. Paul-Dubois. Report (No. 1) for France, on question VIII. for discussion at the seventh session of the Railway Congress. Ills. 30700 w. Bul Int Ry Cong—March, 1905. No. 69520 E.

On the Question of Electric Traction. Victor Tremontani. Report No. 4 on subject VIII. for discussion at the seventh session of the Railway Congress, for all countries, except America, France, Great Britain and Belgium. 8600 w. Bul Int Ry Cong—April, 1905. No. 69880 E.

The Electrification of Trunk Lines. L. R. Pomeroy. A study of the comparative cost of operating, and the cost of installation. 4800 w. R R Gaz—Vol. XXXVIII., No. 20 No. 69652.

Explosion.

Explosion of a Locomotive Boiler (L'Explosion d'une Chaudière de Locomotive). A discussion of possible causes for the recent disastrous explosion of a locomotive at the Gare Saint Lazare, Paris. 1000 w. Génie Civil—April 15, 1905. No. 69716 D.

Fuel.

Oil Fuel for Locomotives. Howard Stillman. Discusses the use of oil fuel, gives specifications for fuel oil as adopted by the Harriman System, the burners used, the application to locomotive fireboxes, the operation of the oil-burning locomotive, &c. Ills. 5000 w. R R Gaz—Vol. XXXVIII., No. 20. No. 69657.

Gasolene Engines.

English Gasolene Locomotives. Brief illustrated descriptions of a Wolseley light railway gasolene locomotive, and a Maudslay locomotive used for hauling freight cars. 1100 w. R R Gaz—Vol. XXXVIII., No. 21. No. 69875.

Locomotives.

A Freak Locomotive for South Africa. Illustrations and description of a combination rack and adhesion tank locomotive for exceptionally heavy grades. 900 w. R R Gaz—Vol. XXXVIII., No. 17. No. 69282.

A Historical Locomotive. Illustration, with brief description, of the first Oregon locomotive. 400 w. Sci Am—May 27, 1905. No. 69867.

A New Type of Compound Articulated Locomotive. Sections and description of two freight locomotives recently built for the Northern Railway of France. 700 w. Ry Age—April 28, 1905. No. 69280.

A Tabular Comparison of Notable Examples of Recent Locomotives. Gives table of passenger locomotives, and of freight locomotives, arranged with respect to classes and weights. Am Engr & R R Jour—May, 1905. No. 69305 C.

Common Standard Locomotives. An account of the complete locomotive standards adopted on the Harriman Lines, indicating the economical advantages. 900 w. Ills. Am Engr & R R Jour—May, 1905. Serial. 1st part. No. 69309 C.

Compound Superheater Freight Locomotive. Illustration, with brief description of an engine of the 2-8-0 type, having Cole superheaters in service on the "Soo Line" railway. 400 w. Am Engr & R R Jour—May, 1905. No. 69307 C.

Four-Cylinder Balanced Compound Locomotives. F. J. Cole. Explains the reasons which led to the use of these locomotives, stating some of their advantages, giving illustrated descriptions of many applications to different types of locomotives. General discussion. 10800 w. Pro Ry Club of Pittsburgh—Jan., 1905. No. 69378 C.

Four-Cylinder Compound Locomotives in America. F. J. Cole. Explains some of the conditions on American railroads which make this type of advantage, and reviews briefly the history of four-cylinder, balanced engines in this country. Ills. 3000 w. R R Gaz—Vol. XXXVIII., No. 20. No. 69651.

Great Western Locomotives and Their Recent Work. Charles Rous-Marten. Comments on recent changes, and on the striking features of some of the new engines is given in the present number. 2800 w. Engr, Lond—May 12, 1905. Serial. 1st part. No. 69834 A.

Locomotive Development on the Pennsylvania Railroad, 1849-1905. C. H. Caruthers. Gives diagrams to scale showing the development in size during 56 years, with notes. 1200 w. R R Gaz—Vol. XXXVIII., No. 17. No. 69281.

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Maine Central Ten-Wheel Locomotive. Illustrations, descriptive specification, and notes. 600 w. Ry & Engng Rev—May 13, 1905. No. 69606.

On the Question of Locomotives of Great Power. J. E. Muhlfeld. Report (No. 2) for America, on Subject V. for discussion at the seventh session of the Railway Congress. Tables and Ills. 35000 w. Bul Int Ry Cong—March, 1905. No. 69518 E.

Rack and Adhesion Locomotives for Central South Africa. Illustrated detailed description. 1000 w. Ry Age—May 19, 1905. No. 69667.

Recent Development of the Four-Cylinder Balanced Locomotive. A. von Borries. Discusses essential points and gives suggestions of value, with comments on superheating. 3000 w. Am Engr & R R Jour—May, 1905. No. 69306 C.

Tank Locomotives. E. E. R. Tratman. Discusses the advantages and disadvantages of tank engines, giving particulars of the tank engines employed in this and other countries. General discussion. Ills. 11700 w. Pro W Ry Club—April 16, 1905. No. 69642 C.

Tank Locomotive (3-Ft. Gauge) for the Cavan and Leitrim Railway. Illustration and drawings, with brief description of an engine for very severe conditions of service. 400 w. Engng—May 5, 1905. No. 69593 A.

The Compounding of Locomotives. A. T. J. Kersey. Abstract of a paper read before the Swindon Engng. Soc. The present number considers the advantages due to compounding in marine engines, contrasting conditions of working, and discussing the considerations, and the possibilities of a condenser. 2800 w. Mech Engr—May 13, 1905. Serial. 1st part. No. 69820 A.

Reversing Gear.

Steam Reverse Gear Once on P. & R. Illustrated description of a device in use on the Philadelphia & Reading passenger locomotives before balance valves were used. 700 w. Loc Engng—May, 1905. No. 69311 C.

Speed Tests.

Comparative Speed Tests of Steam and Electric Locomotives. A report of a series of tests made April 29 over the experimental track at Schenectady, N. Y., to secure data on the relative acceleration and speed characteristics of electric and steam locomotion. 1400 w. St Ry Jour—May 13, 1905. No. 69525 C.

Steel Cars.

Gibb's Steel Railway Car. Illustrated detailed description of cars constructed for the New York Rapid Transit Subway, with remarks on the general purpose of the cars. 2000 w. Engng—April 21, 1905. No. 69338 A.

Tipping Car.

Lateral Tipping Car (Wagon à Basculement Latéral). Illustrating a sheet iron car of 15 tons capacity, arranged to tip to either side, and provided with automatic couplers. 800 w. 1 plate. Génie Civil—April 15, 1905. No. 69715 D.

Train Lighting.

A New Dynamo for Lighting Railway Trains (Eine Neue Dynamomaschine für Beleuchtung von Eisenbahnzügen). E. Rosenberg. The dynamo is especially designed to be driven from the car axle, and gives a continuous current when rotated in either direction. 2500 w. Zeitschr f Elektrotechnik—April 30, 1905. No. 69778 D.

An Improved Dynamo for Lighting Railway Trains (Eine Neue Dynamomaschine und ihre Anwendung zur Beleuchtung von Eisenbahnwagen). E. Rosenberg. Describing an improved dynamo which gives a current always in the same direction no matter which way it is run. The general application to train lighting is discussed at length. 10000 w. Elektrotech Zeitschr—April 20, 1905. No. 69767 B.

The Improved System of Electric Lighting on the Corridor Trains of the Prussian State Railways (Die Neueren Einrichtungen der Elektrischen Beleuchtung einiger D-Züge der Preussischen Staatsbahnverwaltung). Max Buttner. Showing both independent steam dynamos on the locomotive and dynamos on the car axles. Serial. Part I. 2000 w. Glasers Annalen—May 15, 1905. No. 69782 D.

The Lighting of Railway Cars. E. L. Elliott. Discusses the elements of car illumination, and the improvements in distribution that could be obtained by reflectors and the use of frosted lamps. 2000 w. Elec Rev, N Y—May 13, 1905. No. 69527.

Trains.

On the Question of Lighting, Heating, and Ventilation of Trains. Cajetan Banovits. Report No. 2 for all countries, except America, on Subject IX. for discussion at the seventh session of the Railway Congress. 7 tables. 34000 w. Bul Int Ry Cong—April, 1905. No. 69881 E.

Valves.

New Types of Valves and Valve Gears for Locomotives. Illustrates and describes the Young system, the Allfree-Hubbell system, and the Haberkorn system; three new types designed to improve the steam distribution of locomotives. 4000 w. Eng News—May 4, 1905. No. 69367.

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Vestibule.

Railway-Carriage Vestibule. Illustrations of two forms of this appliance, of English make. 1300 w. Engng—April 21, 1905. No. 69334 A.

Wheels.

Cast-Iron Car Wheels. J. E. Muhlfeld. Discusses the difficulty with the cast-iron wheel as at present produced in the United States, giving results of records and tests, and concluding that the undesirable performance may be overcome, giving suggestions. 2500 w. R R Gaz—Vol. XXXVIII., No. 18. No. 69431.

NEW PROJECTS.

Africa.

The Railways of Africa (Les Chemins de Fer Africains). A general description of existing and projected railways in Africa, with map. 2500 w. Génie Civil —April 29, 1905. No. 69720 D.

Borneo.

The British North Borneo Railway. George Cecil. An illustrated description of the line and its working, with a brief report of the commercial and civilizing results. 1000 w. Eng News—May 4, 1905. No. 69371.

Cut-Off.

The Brilliant Cut-off of the Pennsylvania R. R. An illustrated description of a cut-off built to relieve the congested traffic conditions at Pittsburg; built at a great cost, owing to the rugged country, although but three miles in length. 3000 w. Eng Rec—May 6, 1905. No. 69453.

South Africa.

Railroading in South Africa. George E. Walsh. An interesting account of the progress of railroad building, describing the country traversed, and the change being wrought by railroad transportation. 2000 w. Loc Engng—May, 1905. No. 69313 C.

PERMANENT WAY & BUILDINGS.

Electric Driving.

Electrical Equipment of a Railway Shop. Illustrates and describes the shops of the Great Northern Railway Co., at St. Paul, which were designed especially for motor driving. 5000 w. Elec Wld & Engr—May 27, 1905. No. 69917.

Electric Drive in Railroad Shops. C. A. Seley. Reviews the development of electric transmission as applied to railroad shops, the methods adopted, the systems and applications of power. Ills. 3400 w. R R Gaz—Vol. XXXVIII., No. 19. No. 69512.

Frogs.

On the Question of Improved Rail Crossings. C. W. Buchholz. Report on subject III. for discussion at the seventh session of the Railway Congress. Plates I. to XII. 6300 w. Bul Int Ry Cong—March, 1905. No. 69517 E.

Inspection.

Permanent Way Inspection. Gives details of a new system of permanent way inspection started by the London and South-Western Railway Company. 2000 w. Engr, Lond—May 5, 1905. No. 69601 A.

Rail Joints.

New Solutions for the Rail-Joint Problem (Die Neuen Vorschläge zur Lösung der Schienenstossfrage). Fritz Steiner. With numerous illustrations of the joints used on Continental railways. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—April 14, 1905. No. 69727 D.

Thermit Rail Joints. George E. Pellissier. Describes various devices used to join rails and their degree of success, discussing both the mechanical and electrical aspects, and reviews the history of the continuous rail and the methods applied. Especially describes the method of thermit welding. 6000 w. Jour Worcester Poly Inst—May, 1905. No. 69636 C.

Rails.

Steel Rails. William R. Webster. Gives the full specifications of the Am. Ry. Engng. & Main. of Way Assn. adopted last year. 2200 w. R R Gaz—Vol. XXXVIII., No. 18. No. 69436.

Roundhouses.

American Roundhouses and Their Operation. W. E. Dunham. Discusses the general principles observed in laying out plans for roundhouses, some of the interesting features of certain plans, the requirements, &c., 4000 w. R R Gaz—Vol. XXXVIII., No. 20. No. 69650.

Sand Houses.

Sand Houses and Appliances. Illustrates and describes the sand driers, houses and appliances used by different railroads. 1500 w. Ry Mas Mech—May, 1905. No. 69421.

Shop Practice.

The Development of Railroad Shop Practice in the United States. M. K. Barnum. Discusses the present tendency in all shops and the improvement in equipment for securing economy and efficiency, and some of the special details. 2500 w. R R Gaz—Vol. XXXVIII., No. 18. No. 69434.

Signals.

Automatic Block Signals. Ralph Scott. An illustrated description of the Taylor electric interlocking signal. 4500 w. Am Elect'n—May, 1905. No. 69360.

Discipline of Trainmen as Relating to Automatic Block Signals. R. G. Kenly.

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Quotes cases showing that signals are not properly observed, and discusses briefly the best discipline and what it aims to accomplish. 800 w. Ry Sig Assn, Adv Paper—May 23, 1905. No. 69681.

Installation and Maintenance of Storage Battery for Track Circuits. C. C. Anthony. Gives data showing the storage battery to be well adapted to meet the requirements for track circuits. Discusses battery resistance. 3800 w. Ry Sig Assn, Adv Paper—May 23, 1905. No. 69682.

Railway Signalling in America. The present number reviews the remarks of Lord Claud Hamilton, after a seventeen days' visit in America, during which he studied railway methods, and discusses briefly the different conditions in England and the United States. 2100 w. Engr, Lond—May 12, 1905. Serial. 1st part. No. 69836 A.

Review of Signaling Since the Last Congress. B. B. Adams. A review of American and European practice during the last five years in the field of railroad signaling. 2300 w. R R Gaz—Vol. XXXVIII., No. 20. No. 69655.

The Semaphore Spectacle. W. H. Elliott. Discusses the proper design and requirements of the frame used to hold the colored glass for night indications, and also to support the signal blade or arm. 2000 w. Ry Sig, Assn, Adv Paper—May 23, 1905. No. 69684.

Terminal Improvements.

Recent Improvements at West Milwaukee, C., M. & St. P. Ry. Illustrated description of new buildings, and installation of modern appliances. 2500 w. Ry & Engng Rev—April 29, 1905. No. 69294.

Ties.

Ties and Timber Treatment. Hermann von Schrenck. A review of the best American practice at the present time. 2800 w. R R Gaz—Vol. XXXVIII., No. 18. No. 69432.

Train Staff.

Train Staff Operation on New Zealand Railways. Nearly full consular report, giving the general regulations and details of the system which has been in operation eight months. 8000 w. Ry & Engng Rev—April 20, 1905. Serial. 1st part. No. 69295.

Warehouses.

The Electrification of Goods Warehouses on the Lancashire and Yorkshire Railway. Brief illustrated description of the application of electrical energy to warehouses and cotton sheds to facilitate the rapid loading and liberating of wagons. 2400 w. Elec Engr, Lond—April 28, 1905. No. 69467 A.

Yards.

Progress in Yard Design. W. C. Cushing. Describes and illustrates briefly some recent work in this field, noting the extensive improvements introduced at great cost. 2 plates. 8000 w. R R Gaz—Vol. XXXVIII., No. 19. No. 69515.

TRAFFIC.

Freight.

Freight Claims. W. A. Terry. Discusses difficulties due to carelessness of both shippers and carriers and the placing of the responsibility, and matters relating to adjustment. General discussion. 16000 w. Pro Ry Club of Pittsburgh—Feb., 1905. No. 69643 C.

Freight Trains.

The Heavy Freight Train in American Railroad Practice. George R. Henderson. Discusses the effects of overloading, giving tables showing average earnings per ton-mile, average weight of train, and average cost of haulage, &c., and the handling of heavy freight trains. 4000 w. R R Gaz—Vol. XXXVIII., No. 18. No. 69433.

Rates.

On the Question of Slow Freight Rates. W. J. Van Overbeek de Meyer. Report (No. 3) for all countries, except America, England, Italy, Spain, Portugal, France and Belgium, on subject XIII. for discussion at the seventh session of the Railway Congress. Tables. 31500 w. Bul Int Ry Cong—March, 1905. No. 69519 E.

Rate Making by Government. Hugo Richard Meyer. Discusses the problem of rate regulation, considering the American rate practices which the Interstate Commerce Commission has condemned. Concludes that the evils from government regulation would be far greater economically and more disastrous politically, than the evils which now exist. 6000 w. R R Gaz—May 12, 1905. No. 69516.

MISCELLANY.

Accounting.

Note on the Organization of the Accounts Department of the Belgian State Railways. Question XIIII. of the seventh session of the Railway Congress, following on a study of railway book-keeping generally. 38300 w. Bul Int Ry Cong—April, 1905. No. 69882 E.

France.

The Railway Situation in France. L. J. Carlier. Describes briefly the system of operation by companies under franchise, indicating how the companies are constituted, their relations with the state, and their prerogatives in commercial affairs. 2500 w. Ry Age—April 28, 1905. No. 69278.

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Interstate Commerce.

Growing Sentiment for a Properly Constituted Commission. J. W. Midgley. A discussion of the need of a commission to regulate railroads, giving the views of prominent writers as well as the opinions of the writer. 2800 w. Ry Age—May 12, 1905. No. 69533.

Peru.

Railway Development in Peru. C. Reginald Enock. A brief account of extensions which will be of great advantage to the country. 1000 w. Eng News—May 4, 1905. No. 69369.

Progress.

The Progress of American Railroads in the Last Quarter Century. S. Whinery. Considers the features of progress in the period from 1878 to 1903. 3500 w. R R Gaz—Vol. XXXVIII., No. 20. No. 69654.

Spain.

The Northern Spanish Railway. Col. L. Cubillo. Illustrated description of the railway across and along the Pajares pass. 800 w. Ry Age—May 26, 1905. No. 69895.

Train Service.

Impressions of Foreign Railroad Practice. The first of a series of articles giving interesting comparison of English, French and German practice. 1500 w. Am Engr & R R Jour—May, 1905. Serial. 1st part. No. 69308 C.

STREET AND ELECTRIC RAILWAYS

Cars.

New Semi-Convertible Cars with Steel Underframes, for the Brooklyn Rapid Transit Company. Illustrated detailed description of the interesting features of construction in these new cars. 5500 w. St Ry Jour—May 6, 1905. No. 69441 C.

New Wrecking Tool Cars for Elevated Railway Service. Illustrated description of two new wrecking tool cars for the Brooklyn Rapid Transit. 2800 w. St Ry Jour—May 13, 1905. No. 69524 C.

Electric Railways.

Electric Railway Competition. Ray Morris. A study of the effect of interurban roads on short-haul passenger traffic, giving reports of conditions on various lines, and discussing questions bearing on the subject. 4500 w. R R Gaz—Vol. XXXVIII., No. 19. No. 69514.

Electric Traction.

Statistics of the Growth of Electric Traction. W. Pollard Digby. Gives statistics for the United Kingdom in regard to capital invested, mileage, &c. 1200 w. Elec Mag—April 25, 1905. No. 69614 C.

Feeders.

Feeders and Returns of Electric Tramway Systems. H. E. Yerbury. Read before the Leeds Soc. of the Inst. of Elec. Engrs. Discusses only systems supplied with power from one generating station at 500 to 550 volts. Ills. 4500 w. Tram & Ry Wld—May 4, 1905. No. 69678 B.

Freight Service.

The Electric Railroad Freight Service. H. H. Polk. Read before the Iowa St. & Inter. Ry. Assn. A general discussion of the service, its convenience to farmers, the profits to be realized, &c. 2500 w. St Ry Rev—May 15, 1905. No. 69609 C.

Heavy Haulage.

Electricity vs. Steam for Heavy Haulage. A. H. Armstrong. An inquiry into the limitations of steam locomotives, and comparing with the tests made upon the electric locomotives designed for the N. Y. C. R. R. 3500 w. St Ry Jour—May 6, 1905. No. 69443 C.

Mount Vesuvius.

The Plant of the New Electric Railroad Up Mount Vesuvius. Illustrated detailed description. 1500 w. Sci Am Sup—May 13, 1905. No. 69489.

Moving Platform.

Moving Platform Subway for New York. Discusses the project, and the decision of the Rapid Transit Commission to reserve 34th St. for a four track subway. Also editorial discussing the economies of the moving platform, and full-page illustration. 2000 w. Sci Am—May 13, 1905. No. 69486.

Operation.

Some Operative Features of the Aurora, Elgin & Chicago Railway Co. An illustrated article reviewing briefly the installation, and the changes and additions made. 4500 w. St Ry Rev—May 15, 1905. No. 69608 C.

Public Service.

The System of the Bloomington & Normal Railway, Electric & Heating Company. C. H. Robinson. An illustrated account of a company furnishing transportation facilities and also carrying on a general lighting and heating business. 1800 w. St Ry Jour—May 27, 1905. No. 69898 C.

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Recording.

Diagram for Recording Overhead Data. Illustrated explanation of the method used by the Hartford Street Railway Company. 600 w. St Ry Jour—June 3, 1905. No. 70050 C.

Repair Shops.

A Departure in Repair Shop Accounting. Describes a system in which all repair work, except that required for the bare operation of cars, is done by estimate. The plan was instituted by W. E. Harrington, and has been in use several years on the S. Jersey Div. of the Public Service Corporation. 2500 w. St Ry Jour—May 20, 1905. No. 69668 C.

Signaling.

Signaling in the Subway. J. M. Waldron. Describes this very successful system of block signaling and the care given it to keep it in perfect order. 2500 w. Ry Sig Assn, Adv Paper—May 23, 1905. No. 69683.

Single-Phase.

Car Equipment of the Indianapolis & Cincinnati Traction Company. Illustrated description of the cars of this single-phase line. 1100 w. Ry Age—June 2, 1905. No. 70045.

The Stubaital Single-Phase Railway. Illustrated detailed description of this single-phase current railway in Austria. 1100 w. Elect'n, Lond—May 5, 1905. No. 69589 A.

Sprinklers.

Sprinkler Test in Cleveland. A summary of tests made to determine the value of this system of fire proctection. Ills. 1400 w. St Ry Jour—June 3, 1905. No. 70047 C.

Storage Yard.

A New Storage Yard and Shop Plant for the Brooklyn Transit Company. Illustrates and describes the yard under construction for the accommodation of the elevated and surface lines of the eastern district of the city. 2500 w. St Ry Jour—June 3, 1905. No. 70048 C.

Trolley Wires.

Overhead Accidents and Their Prevention. Discusses the risks from defective design or construction, defective maintenance and from lack of foresight. 2000 w. Elec Rev, Lond—May 5, 1905. Serial. 1st part. No. 69587 A.

Valtellina.

An Electric Locomotive with Coupling-Rod Drive. Illustrated description of new electric locomotives for the Valtellina line in which the motors are mounted on independent shafts carrying a crank at each end, and actuate the driving wheels by means of coupling rods. 1500 w. Eng News—May 1, 1905. No. 69368.

New Electric Locomotives on Italian Railways. Frank C. Perkins. Illustrated detailed description of high power alternating current electric locomotives recently placed in operation on the Valtellina three-phase electric railway. 3000 w. Ry & Engng Rev—May 20, 1905. No. 69694.

The New Electric Locomotives for the Valtellina Railway (Les Nouvelles Locomotives Electriques des Chemins de Fer de la Valteline). Illustrated description of the 62 ton, three-phase locomotives recently put into service on the Valtellina railway in Northern Italy. 2500 w. 1 plate. Génie Civil—April 22, 1905. No. 69717 D.

The Valtellina Railway. An explanation of the conditions that led to the adoption of electric locomotives for this line, with much interesting information in regard to tests made and their general working; also a report of the working costs. 2600 w. Engr, Lond—May 5, 1905. No. 69596 A.

The Valtellina Railway. E. Cserhati. Discusses the working costs and test figures obtained with three-phase traction. 3500 w. Elec Engr, Lond—May 5, 1905. No. 69585 A.

Vienna.

The Street Railways of Vienna (Die Städtischen Strassenbahnen in Wien). Gustav Wärmer. A very complete account of the electric tramway system of Vienna, showing the growth during the past ten years. 5000 w. 3 plates. Oesterr Wochenschr f d Oeffent Baudienst—April 22, 1905. No. 69759 D.

Walthamstow.

The Light Railways of Walthamstow. Gives briefly the history of the undertaking, with an illustrated detailed description of the tracks, overhead equipment, generating station, &c. 5500 w. Tram & Ry Wld—May 4, 1905. No. 69677 B.

Wheels.

Wheel Grinding on the Boston Elevated Railway. Explains the methods of maintaining wheels, the wear upon passenger cars being so great that the wheel has to be ground every two weeks. Ills. 2000 w. St Ry Rev—May 15, 1905. No. 69607 C.

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EXPLANATORY NOTE—THE ENGINEERING INDEX.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Air Power. *qr.* New York.
American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architecaural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b.-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Engineering Papers.

The Principal Professional Papers of Dr. J. A. L. Waddell. Edited by John Lyle Harrington. Size, 9 in. by 6 in.; pp. ix, 992. Price, $5.00. New York: Virgil H. Hewes.

In the course of a professional career of a wide and varied nature Dr. Waddell has given to the engineering profession many valuable and interesting papers, but in most instances these have reached but limited audiences, or have been buried in the transactions of the professional societies before which they were presented. The collection of these writings into a volume of handsome appearance and convenient form is a real service to both the practicing engineer and to the engineering student.

The wide variety of subjects treated renders it impossible to examine the papers in detail, but attention may be directed to those upon the subject of engineering education, and those upon the design of bridges and other structural works. The part which has been taken by Dr. Waddell in engineering education in Japan renders his address to the Japanese Engineering Society of especial interest in view of the developments which have occurred since that time.

An important feature in the work is the fact that such of the papers as were presented before professional societies have the discussions which they elicited appended to them, this giving, in many instances, a most useful expression of opinion of other eminent engineers upon the subjects treated. Engineering literature has not many works of this kind included in it, and as a contribution to the literary, as well as the professional department of applied science it is to be welcomed and appreciated.

Marine Engines.

Marine Engines and Boilers, Their Design and Construction. By Dr. G. Bauer. Translated by E. M. Donkin and S. Bryan Donkin. Edited by Leslie S. Robertson. Size, 9 in. by 6 in.; pp. viii, 772. Price, 25s., $9.00. London: Crosby Lockwood and Son. New York: The Norman W. Henley Publishing Co.

The important position held in Germany by the treatise of Dr. Bauer upon the design of marine engines and boilers renders a translation of the work an occasion for congratulation both to the translators and editor and to the marine engineering profession. Time was when Germany looked to other nations and languages for works of this character, but with the development of German shipbuilding there has grown up a mass of technical literature embodying the experience acquired both at home and abroad, and dealt with in the spirit of German thoroughness which is fully appreciated in England and America.

The successive chapters include discussions of the main engines, in arrangement and in detail; of auxiliary machinery, with especial reference to the pumps for all departments of service; of shafting, resistance of ships, and propellers; and of piping and its arrangement and connections. A separate section is devoted to marine boilers, including the cylindrical, locomotive, and water-tube types; following which are chapters on measuring instruments, minor details, and useful tables. To this translation there has been added the final report of the committee on naval boilers, made to the Lords Commissioners of the Admiralty in June, 1904.

This work is undoubtedly the latest and most complete treatise on the subject of the machinery of steamships which has yet been made, and as such it will doubtless find a place in the working library of the naval constructor and engineer.

BOOKS RECEIVED.

Builders' Hardware. By Henry R. Towne. Price $5.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Diary and Engineering Data for Electrical and Mechanical Engineers. Westinghouse Electric and Manufacturing Co., Pittsburg, Pa.

The Naval Constructor. By George Simpson, M. I. N. A. Price $5.00. New York: D. Van Nostrand. London: Kegan Paul, Trench, Trübner & Co.